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VOL. IV, NO. 2 APRIL, 1922 Old Series: Vol. XX, No. 2

The Journal of Bone & Joint Surgery

SPONTANEOUS HEALING INHERENT IN TRANSPLANTED BONE.

BY S. L. HAAS, M.D., SAN FRANCISCO.

From the Surgical Pathological Laboratory of Leland Stanford, Jr., University School of Medicine.

IT is still contended by some investigators and surgeons that bone after transplantation dies and takes no share in the process of restoration, but functions merely as an inert body, by serving as a framework for the ingrowth of live bone with which it is in contact. By those who hold this view it is further claimed that it is immaterial whether one uses live or dead bone, from the same or some other animal or even a foreign substance for the transplantation material. This idea persists, in spite of the fact that it has been repeatedly shown that there takes place in bone after transplantation definite signs of proliferation from the periosteum, endosteum, and from the lining cells of the Haversian canals. This non-acceptance of the doctrine that a live bone transplant shares in the regenerative processes must be due to the fact that the evidence thus far submitted is not sufficiently convincing to those who hold the opposite view. Therefore, in order to unify our conception regarding this important principle concerned with bone surgery, additional proof must be submitted of the independent activity of osteoblastic tissue after transplantation.

The healing of a fracture calls into play practically every component part of bone and makes as severe a demand upon the reconstructive activities of its various cellular elements as any pathological process

FIG. 1.—Roentgenograms, in planes at right angles, of a phalanx which was completely fractured and then buried in muscle. The bone, which was removed at the end of 73 days, shows complete union of the fracture. Notice the absorption of the bone, resulting from lack of functional stimulation.

of bone. It was, therefore, considered as a suitable test to determine if the cells of bone possess an independent power of proliferation after transplantation, by studying the behavior of the cellular elements and their response toward the healing of a fracture in transplanted bone. In order to guard against the influence of any other osseous tissue, it was essential that the transplant, after fracture, be placed so as not to be in contact with other bones. Therefore, if an entire bone is removed and after being fractured, placed in the muscles of the back, any tendency toward healing of the fracture must be ascribed to the independent proliferative power of the cells of the transplant; and should there be a definite union of such a fracture in a transplant to muscle, then I believe that the most skeptical will have to admit the importance of the inherent activity possessed by osteoblastic tissue after transplantation.

With the above object in view a number of experiments were performed upon dogs, two of which will be briefly reported at this time. All of the experiments were performed under general anæsthesia with the usual aseptic technique.

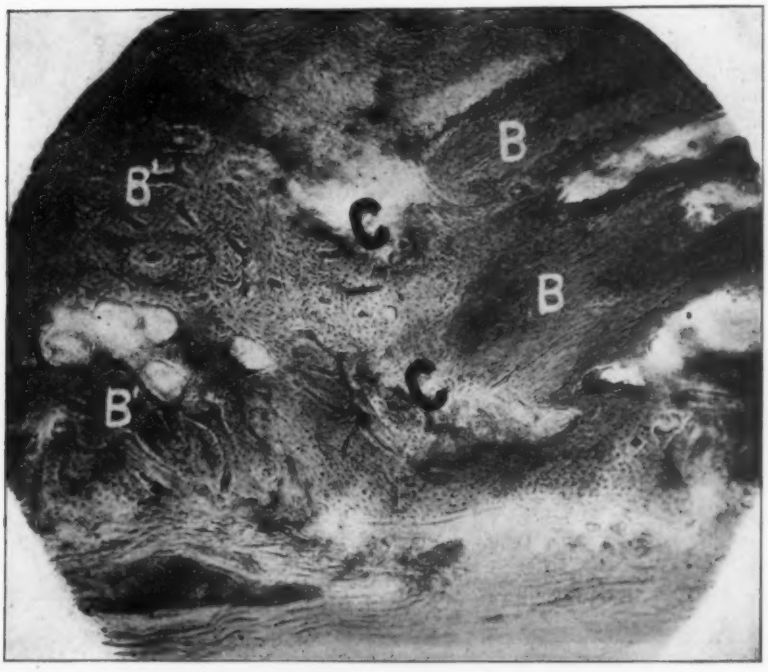


FIG. 2.—Microphotograph of a section through the site of union, of the healed fracture in the transplanted phalanx, removed from the muscles of the back at the end of 73 days. Notice the old bone at *B*, with the intervening new bone, *C*, which is the result of the inherent proliferating power of the cells of the transplant. This section is through the narrow neck of bone shown in the roentgenogram, Fig. 1.

EXPERIMENT 1.—Dog 1.—Full grown. Duration of experiment, seventy-three days.

Operation.—The first phalanx of the fourth toe of the left hind foot was removed intact. It was then fractured completely through the center and after the fragments were placed in apposition they were transplanted to the muscles on the left side of the spine.

Macroscopical Findings.—Seventy-three days. The bone was found encapsulated in the muscles of the back. It was considerably thinner than normal and had evidently undergone absorption. The two fragments appeared to have firmly united. The roentgenogram (Fig. 1) shows two views taken at right angles, and one can see a definite osseous bridge connecting the two fragments.

Microscopical Examination.—A study of the sections shows a definite continuous osseous tract from one articular cartilage to the other. The minute cellular changes will not be discussed in this paper, but one can distinguish the old and new bone at the site of union. The microphotograph (Fig. 2) shows a section through the field of union of the fragments.

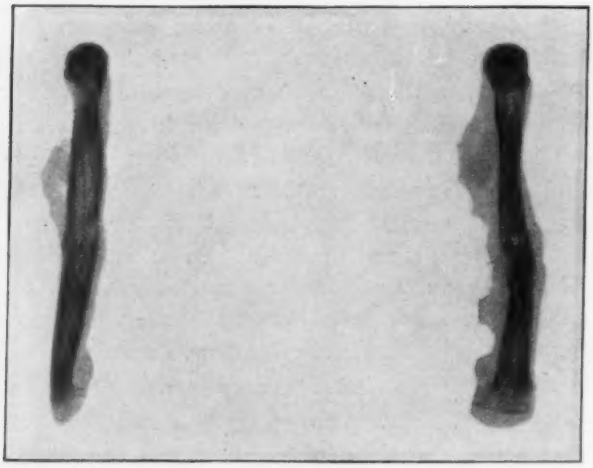


FIG. 3.—Roentgenograms, in planes at right angles, of a metatarsal bone that had been fractured in the center and transplanted to the muscles of the back. The bone was removed at the end of 71 days and showed firm union. Notice the bridging of the bone at the fracture plane. The bone is undergoing absorption.

Deductions.—The two fragments of bone after transplantation possessed the same tendency toward healing as two fragments of a fracture in a normal position. From the study of other experiments it can be stated that the process is identical, and union takes place after the formation of a cartilaginous callus, which later undergoes ossification. Because of the fact that the bone is transplanted to muscle, is removed from any possible influence of extraneous osseous tissue, any changes taking place must be ascribed to the energy that is stored in the cells of transplant itself. On account of the bone being removed from the influence of normal functional stimulation, there will take place a slow degeneration after the initial active response.

EXPERIMENT 2.—Dog 3.—Young, full grown. Duration of experiment, seventy-one days.

Operation.—Removed the entire fourth metatarsal bone from the right hind foot. The bone was fractured completely across the center, except for a small strip of periosteum, and then buried in the muscles on the left side of the spine.

Macroscopical Findings.—At the end of seventy-one days, the bone was found encapsulated in the muscles and was smaller than when it was inserted. The union of the fragments is firm and there is very little evidence of any callus. The roentgenogram (Fig. 3) shows the line of fracture, which in places is bridged by new bone.

Microscopical Examination.—A section through the bone at the site of the fracture (Fig. 4) shows, on one side, a definite osseous connec-

FIG. 4.—Microphotograph of a section through the site of union of a fracture in a transplanted metatarsal bone removed from the muscles of the back at the end of 71 days. *A*, *A'*, the old bone fragments. Notice the loss of nuclear staining and degenerated appearance. *C*, *C'*, new bone at the fracture line. This is also undergoing degeneration. After the initial degeneration with union of the fragments there takes place a secondary degeneration because of the lack of functional stimulation.

tion between the two fragments. In spite of the union and evidence of proliferation, the osseous tissue of the original bone, as well as of the callus, has lost the greater part of its nuclear staining. This is undoubtedly due to a secondary degeneration.

Deductions.—The condition here suggests that there was an early regeneration and formation of a callus. Then, again, because of the lack of functional stimulation a final degeneration took place.

GENERAL SUMMARY.

Bone when transplanted into a muscular bed, and thereby removed from any possible influence of other osseous tissue, shows definite signs of cellular activity. It has been previously shown,[1] that even though there is an initial degeneration of the greater part of a transplanted bone, that a sufficient amount of osteoblastic tissue survives

in the region of the periosteum, endosteum, and about the Haversian canals, to regenerate the new bone. Furthermore, if the transplanted bone is not subjected to functional stimulation[2] it will gradually undergo a second and permanent degeneration.

In the case of transplanted bones in which fractures have been produced, there is made an additional demand upon the regenerative powers of osteoblastic tissue. This demand is complied with in just such a way as normal bone responds to the call for the repair of a fracture, namely: the formation of cartilaginous callus which later becomes ossified. This response takes place, even though the bone is removed from the normal functional stimulation, but on account of the lack of functional demand it, too, undergoes degeneration.

In view of the fact that the osteoblastic components of a transplanted bone possess sufficient energy to produce the union of a fracture, even when buried in muscle, there must be ascribed a considerable importance to the regenerative powers of the cells of such a live piece of bone.

CONCLUSIONS.

1. There is sufficient energy stored in the osteoblastic cells of a live bone transplant, placed in a muscle and removed from all osseous contact, to form a union between two fragments of a fracture produced in such a transplant.

2. Because of this very active, independent, regenerative and reparative property innate in the live bone transplant it is advisable to utilize living bone, whenever possible, for any purpose where a transplant is indicated.

(I wish to extend my thanks to Professor Blaisdell for the privileges granted to me during this experimental study.)

REFERENCES.

1. Haas, S. L.: The Transplantation of the Articular End of Bone Including the Epiphyseal Line. Surg., Gynec., and Obst., xxiii, 301, Sept., 1916.
2. Haas, S. L.: Function in Relation to Transplantation of Bone. Arch. of Surg., iii, 425, Sept., 1921.

NOTE ON SACRALIZATION OF THE FIFTH LUMBAR VERTEBRA.*

BY C. THURSTAN HOLLAND, D.L., M.R.C.S.,
Lecturer on Radiology, The University of Liverpool.

Of late years the condition known as Sacralization of the Fifth Lumbar Vertebra has come into considerable prominence on account of the fact that radiography has thrown its beam of light upon a condition about which previously very little was known, and which most certainly is entirely undiagnosable without an x-ray examination and is rarely if ever suspected of being present from any symptoms which may be complained of.

Until recent years there was very little literature on the subject, and practically all there was was purely anatomical. Thus the Index Medicus from 1917 to 1920, inclusive, gives no references under the heading of Sacrum or Sacralization, but in 1921 a considerable number of papers are recorded.

The late Professor Paterson, of Liverpool University, published a monograph in the *Scientific Transactions of the Royal Dublin Society* in 1893, on the Sacrum—*i.e.*, two years prior to the discovery of x-rays. He points out in this paper, which is a very elaborate one, that the lateral mass of the sacral region equals (or represents) the transverse processes and ribs of the thoracic portion of the spine; he figures two unilateral and three bilateral cases of sacralization, and one embryo of seven months with the unilateral condition.

Young, in the *American Journal of Orthopaedic Surgery*, in 1916, on the x-ray examination of the lumbo-sacral region, notes that congenital irregularities have long been recognized and that irregular formation of one or both transverse processes of the fifth lumbar vertebra has been considered as a frequent etiological factor in scoliosis. He also notes that the irregularities of the deposit and development of the centers of ossification of the fifth lumbar vertebra are so variable that the late Professor Thomas Dwight was doubtful as to what should be considered the normal.

Japiot, in 1914, when reporting two cases of sacralization, states that at that time he could find only five references in literature. Since that time, however, there have been a large number of cases reported.

* Paper read before the British Orthopædic Association at the Annual Meeting, held in Liverpool on December 2nd, 1921.

For instance: Rossi (Italy) in 1917–1918 reported 22 cases; Richard (America) in 1918, 54 cases; Nové-Josserand et Rendu (France) in 1919–1920, 19 cases; Japiot (France) has radiographed at least 20 cases, whilst during the last twelve months a great many authors—chiefly French—have placed on record numerous cases.

The condition, as far as I know, has received little or no attention in England, and I have not been able to find any reports of cases or any radiographs of this condition in our journals. In Ireland, however, Hayes (Dublin) has reported four cases in the *Dublin Journal of Medical Science,* in the April number, 1921. He also states that no case of operative treatment resulting in a complete cure has been reported.

It is evidently a common condition, and one, I think, which requires a certain amount of surgical consideration, in view of the undoubted fact that pain of some kind or another is so frequently present in the cases in which the deformity is found. Always admitting the somewhat voracious appetites of the orthopædic surgeons during the past few years, I take it that this condition may be justly considered as a part of their regular diet; this must be my excuse for bringing it before you.

I have seen ten cases during the present year, and produce radiographs of these cases: eight in females, two only in males. The ages vary from 2½ years up to 59 years, three in children of 10 years and under, the remainder in adults. The one in a child of 2½ years is of interest inasmuch as it shows the development of the lateral masses of the sacrum from separate centers, and complete fusion has not yet taken place. Five cases are symmetrically bilateral. Five cases are unilateral. In four of these there is an abnormal appearance of the transverse process on the opposite side.

The symptomatology is of some interest. Pain in the region of the back is what is usually complained of in most of the cases in which this condition has been discovered radiologically, but in one of my cases the discovery was entirely accidental, as no pain whatever which could have had any relationship to the presence of sacralization was complained of. The radiograph was taken because pus had been discovered in the urine. Others have also noted that the condition may be painless. We also have the fact, of course, that existing from the time of development, the condition may be painless for a large number of years and the history frequently given is pain for a few years only, or for even much less.

Probably the usual diagnosis in these cases at first, at any rate, is lumbago, and no doubt many continue for years and have the usual treatments given for this complaint. Osteoarthritis of the lumbar spine would also have to be considered. However, by far the larger number of cases—all mine except one—are sent to the radiologist with a request for an x-ray examination of the kidneys, ureters, or bladder, the suspicion being that the pain may be caused by stone. In none of my cases was a stone present.

It does not necessarily follow that the pain in these cases is due to the sacralization, but that after all is, and can be, only an inference; but the cause of the pain is generally obscure and the pain itself is indefinite in character, so that in the absence of any other known cause, and in the presence of an otherwise negative x-ray examination, it seems fair to suspect the only abnormality which can be found, namely, the sacralization, as a probable cause of the trouble.

Two questions arise: Why should it give rise to pain? Why can it exist for many years without pain and then, in some cases, give rise to a pain which begins slowly, and gradually gets worse and worse, and in others commences with an attack of acute pain?

Various causes have been put forward, and these may be summarized as follows:

1. Actual pressure on nerves or nerve trunks.
2. Ligamentous strain.
3. Compression of soft tissues between bony joints.
4. By an actual arthritis if a joint is present.
5. By a bursitis if a bursa is present.

There is the additional point that a trauma may be the exciting cause, especially in those cases of sudden and acute pain.

In one of my cases, which I shall refer to again, I consider that the radiograph distinctly suggests a definite joint, and also indicates an osteoarthritis. This was a unilateral case, with pain on the side of, and in the region of, the abnormality.

As to the treatment of this condition: Els (of Bonn) advises operation in pain from definite sacralization; Merklen and de Gery (Paris) advise resection, but state that up to the present (1920) the results are not very striking; Japiot (Paris), 1921, states that in four operations performed in America, only amelioration, and not cure, resulted. He himself has treated the pain by x-ray therapy with promising results. (As a comment of this, it is extraordinary what a lot of conditions have been treated with x-rays with "promising results.")

I take it that cases for operation should be very carefully selected, and that to jump at operation merely on the x-ray findings would be absurd. There should, at any rate, be some definite grounds for the assumption that the condition in each individual case was the probable source of the pain. My material bearing on this matter is small but, at the same time, significant. One case, a woman aged 30 years, in a medical ward of the Royal Infirmary, was referred to me by Dr. Abram for an examination of the kidneys. In the routine of this examination, nothing was found, but a unilateral sacralization plus a somewhat abnormal transverse process on the other side, were shown. This is the case already alluded to as suggesting a joint plus osteo-arthritis. The pain—twelve months' duration—was definitely on the side of the sacralization. Knowing at that time nothing about the subject, I naturally rushed in where angels fear to tread (I, of course, refer to yourselves, gentlemen), and suggested an operation.

A few weeks later an osteotomy and removal of bone was done by Mr. Jeans. Four months later, in reply to enquiries, I received the following letter: "I am pleased to say that I have had no return of pain since, and have been much better in health. I will take this opportunity of thanking all those who helped to restore me to health, and I cannot say how grateful I am."

One case of success is, of course, not very much to go upon, and even in this case no great length of time has elapsed since the operation. At the same time it has its significance, and I suggest that the condition of sacralization deserves your attention.

BIBLIOGRAPHY.

PATERSON: Scientific Transactions of the Royal Dublin Society, Vol. v (series 11), p. 123, 1893.
ADAMS: American Journal of Orthopædic Surgery, Nov., 1910.
GOLDTHWAIT: Boston Medical and Surgical Journal, 1911.
KLEINSCHMIDT: Ztrbl. für Chir., May 11, 1912.
DENNIE: Revue d'Orthopédie, December, 1913.
CALVÉ: Orthopédie et Tuberculose Chirurg., Jan., 1914.
JAPIOT ET SANTY: Revue d'Orthopédie, May, 1914.
JAPIOT: Lyon Medical, May, 1914.
YOUNG: American Journal of Orthopædic Surgery, November, 1916.
ELS: Beitr. z. klin. Chir., Vol. 95.
BERTOLOTTI: La Radiologia Medica, 1917.
ROSSI: La chirg. degli Organi di Movimento, 1919.
RICHARDS: American Journal of Roentgenology, 1919.
NOVÉ-JOSSERAND: Lyon Chirg, 1919.
RENDU ET ARCELIN: Lyon Medical, 1920.
JAPIOT: Lyon Medical, 1920–1921.
NOVÉ-JOSSERAND ET RENDU: Presse Médicale, 1920.

MAUCLAIRE: Soc. de Chirg. de Paris, 1920, April, June, December.
MAUCLAIRE, DELHERM, THOYER-ROZAT: Bull. et Mém. de la Soc. de Chirg., 1920.
CLAP: Bull. et Mém. de la Soc. Anatomique de Paris, 1920.
OLIVIER: Ibid., 1920.
SOUNDAT: Gaz. Méd. de Picardie, 1920.
GEORGET: Thèse de Lyon, 1920.
KEATING-HART: L'évolution Médico-Chirurg., 1920.
MERKLIN AND FÉVRIER: Bull. et Mém. de la Soc. Médicale des Hôpitaux de Paris, 1920.
LEDOUX AND CAILLODE: Presse Méd., Paris, 1921.
DELHERM ET THOYER-ROZAT: Bull. Médicale, 1921.
MAUCLAIRE: Bull. de la Soc. de Chirg., 1921.
HAYES: Dublin Journal Med. Science, 1921.
MICHEL: Gaz. des Hôpitaux, 1921.
OLIVIER ET DARBOIS: Bull. Soc. Radiolog. Méd. de France, 1921.
LUPO: La Chirg. degli Organi de Movimento, 1921.

A NEW METHOD OF OPERATIVE TREATMENT OF FOOT DEFORMITIES.

BY O. E. SCHULZ, M.D., PRAGUE, CZECHOSLOVAKIA,
Yedlicka's Institute for Crippled Children.

THE correction of a faulty position of calcaneus is a matter of greatest difficulty in both congenital and acquired deformities of the foot. The correction of the heel might be performed instrumentally or manually, but it is the retention of the corrected or overcorrected position which is so extremely difficult.

In correcting the deformity of the forefoot by redressement, we force the small bones of the forefoot one against the other one, but in the heel we find only one hard and very solid bone, deformed in its structure and form, joined by means of strong ligaments to the astragalus, fibula, and tibia. Such a bone is not easy to correct.

Unfortunately, a recidive of club or flatfoot begins always in the heel, which first goes back to its former wrong position. For this reason a perfect cure is secured only by an overcorrection and retention in the overcorrected position of the calcaneus.

In flatfoot we have corrected the deformity by osteotomy. *Gleich* made an oblique osteotomy of the calcaneus from the front and inside to outside and backward. Then he pushed the rear fragment forward and inside and finished the operation by achillotenotomy. *Brenner* performed the same operation from the inside. *Frisch* proceeds from the outside and nails the processus posterior calcanei from behind. *Perthes* cuts out a piece of the os naviculare and implants it in a linear osteotomy in the processus anterior calcanei. *Wilms* does a similar operation, implanting the piece between the os cuboideum and the calcaneus.

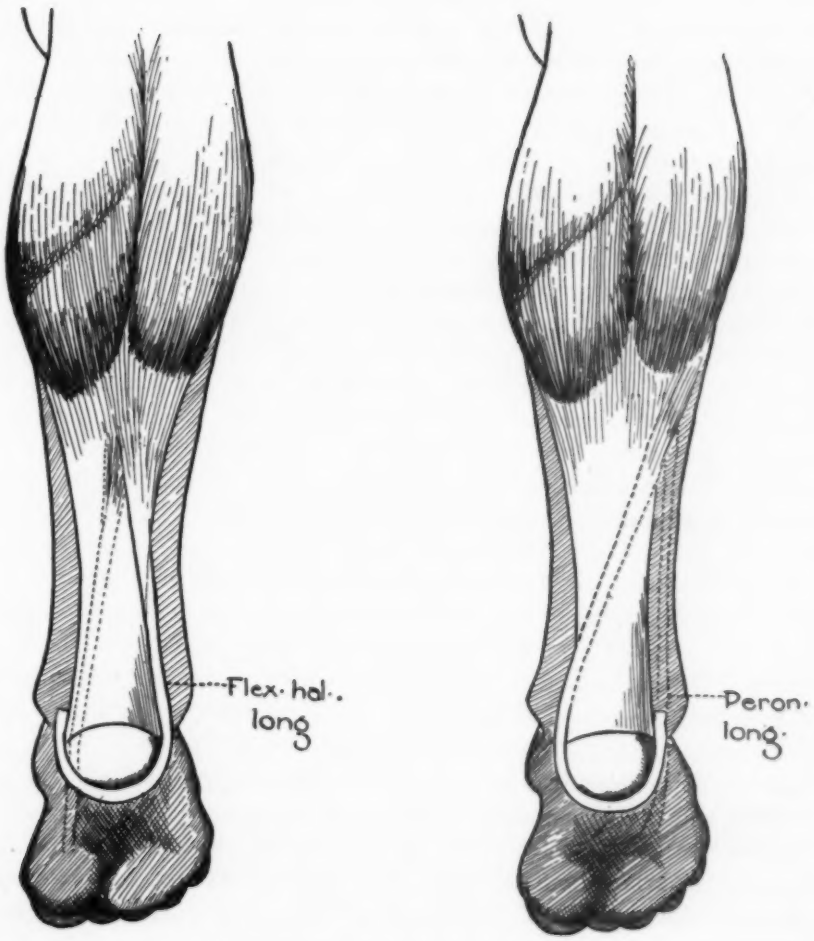
Lorenz, four years ago, recommended a simple operation. He made a skin incision against the Achilles tendon, stripped the skin out and inside of the tendon, chiseled away the insertion of the tendon with the epiphysis of the os calcaneum, pushed the tendon with the fragment outward in case of a clubfoot, inward in a flatfoot, and finally fixed the bone in the overcorrected position by a nail.

The purpose of all these operations is the supination and adduction of the heel. Following the same purpose *Franke Frank, Vulpius* and others shortened the tendon of the musc. tibialis posterior, *Hübscher* shortened the tendons of the flexors of the toes, *Ryerson* transplanted the musc. peronæus longus on the os cuneiforme; *T. R. W. Armour, C. B. Edin* and *Naughton Dunn* excised a portion of the peronæus tendon and paralyzed artificially the nervus peronæus.

All these transplantations have only an indirect influence upon the heel, the new insertion of the transplanted tendon working directly in the elevation of the inside of the foot and only indirectly in the supination of the heel.

My aim was to produce a supination of the heel by means of a strong tendon and at the same time to secure the important adduction and inward rotation of the heel. For this reason I worked out the following method:

I cut the tendon of the musculus peronæus longus in the sole, pull out the dissected tendon behind the malleolus externus and conduct it inside between the gastrocnemius and the flexor of toes to the hind part of malleolus internus. Then I make a canal between the plantar side of calcaneus and ligamentum plantare longum and carry the tendon backward under the calcaneus to the outside, where I fix it to the periosteum of the lateral side of the calcaneus. At the same time I produce an inward rotation, adduction, and supination of the heel. The tendon of the musc. peronæus longus has now its route from outside to inside,



Tendon Operation for Foot Deformity.

returning back to the outside under the calcaneus. A contraction of the transplanted tendon will produce a strong adduction, supination, and inward rotation.

OBSERVATIONS.

I. Girl, 12 years. Poliomyelitis at the age of four years. Right foot is in abduction, heel in abduction and outward rotation. Musc. tibialis posterior and flexor digitorum are paralyzed. Tibialis anterior, extensor digitorum and both peronæi in a pretty good condition. Operation: 1. Incision on the outside of the foot; both peronæi cut. 2. Long incision behind the malleolus externus. 3. A similar incision behind the malleolus internus. 4. The tendon of the peronæus longus pulled out behind the malleolus externus. Both tendons carried through the space between the musculus gastrocnemius and the flexors to the inside. The peronæus longus tendon conducted back to the outside under the calcaneus. The heel adjusted to a maximum of adduction and supination. The free end of peronæus brevis fixed with silk to the periosteum of the inner side of calcaneus, peronæus longus to the outside of the same bone. Incisions sewn with catgut. Plaster dressing in the overcorrected position. Two months later: Foot in a good position; patient walks with her foot in supination. Eight months later: Condition same.

II. Girl, 5 years. Poliomyelitis when one year old. Left foot in abduction, outward rotation, and pronation. Musculi tibialis anterior, flexor hallucis longus, and tibialis posterior paralyzed. Extensor digitorum and peronæi in an excellent condition. The last named muscle is very well developed and dislocated to the front of malleolus externus.

The same operation performed with the exception that only the peronæus longus was cut.

Three months later: The child walks without difficulty in orthopædic shoes with a light support (inlay). Foot in good position.

If we now turn to consider the question of clubfoot we find that the calcaneus deformity is here also of the same importance. *Hansen* recommended the excision of a wedge from the lateral portion of the calcaneus with the angle to the inside and infraction of the calcaneus in an overcorrected position. The operations of *Perthes, Wilms,* and *Lorenz,* can easily be modified to the treatment of a clubfoot. Also the operation which I suggest in this paper can be applied to a clubfoot. The tendon of the musc. flexor hallucis longus is cut in the sole, conducted behind the malleolus externus and back to the inside of the heel under the calcaneus.

Observation: Female, 28 years. Poliomyelitis at the age of 4 years. Double clubfoot. Operated at the age of 18 years by redressement. Fibula was broken in both extremities and its distal fragment became dislocated so much that the malleolus was too large for the astralgalus. A few weeks later both feet returned to the same position. Walking possible only with the help of a strong and elaborate apparatus.

I first made an instrumental and manual redressement of both feet and applied a long plaster dressing in an overcorrected position for ten weeks. After this time the patient could walk without any apparatus, in orthopædic shoes only. Foot was in a good position while the patient was standing. During walking the unfirm foot turned outwards.

Six months later the transplantations were made.

Operation on the right foot:

(1) Incision in the sole, 2 inches long, in the center of the first metatarsal. The tendon of the flexor hallucis cut near the junctura tendinum. The distal fragment of the tendon attached with silk to the flexor communis, the proximal end loosened from the junctura tendinum.

(2) Long incision behind malleolus internus. Ligamentum lanciniatum cut. The free end of the tendon pulled out.

(3) Long incision behind malleolus externus. The tendon carried between musc. gastrocnemius and flexor digitorum to the outside.

(4) The canal under the plantar side of the calcaneus prepared. The tendon carried through the canal under the calcaneus to the inner side of this bone and fixed there with silk. Overcorrection of the heel position at the same time.

(5) The tendon of the musc. tibialis ant. was transplanted to the lateral side of the foot.

Operation on the left foot performed in a similar way. Here the tendon was too short and allowed a fixation to the outside of the calcaneus only.

Plaster dressing on both extremities for 10 weeks.

After 10 weeks: The patient walked without any apparatus for three-fourths to one hour without difficulty. Only walking up hill was painful.

The position of the right foot is better than of the left foot, as was expected.

Summary: A new operative treatment of foot deformities is described, based on tendon transplantation of the heel.

EARLY WEIGHT-BEARING IN THE TREATMENT OF AMPUTATIONS OF THE LOWER LIMBS.

BY PHILIP D. WILSON, M.D., BOSTON.

A SUFFICIENT time has passed since the termination of the war to allow us to draw definite conclusions as to the real value of certain surgical procedures which were introduced at that time. Of these the use of weight-bearing in the after treatment of amputations of the lower limb seems definitely to have proved its value and deserves to be applied to the surgery of peace.

Early weight-bearing is obtained by the use of peg legs or articulated limbs of such simple type and construction that their rapid manufacture is possible by almost anyone after a little practice without the necessity of elaborate training or equipment. The apparatus consists essentially of two parts, a socket which is moulded to the stump in order to obtain an accurate fit, and a skeleton frame which transmits the body weight from the socket to the ground.

The chief bearing points utilized are the bony prominences: the tuberosity of the ischium for thigh amputations, and the shelving under surface of the upper end of the tibia in below-the-knee cases. Secondarily, the weight is borne by the soft parts, but always in a manner to relieve the wound of pressure, the lower end of the socket being left open for this purpose.

The socket may be made of papier maché, leather, or plaster of Paris; the frame is usually of wood or light iron. To work successfully the apparatus must combine the following features,—adaptability to various types of stump, strength, lightness, and ease of manufacture.

With such forms of apparatus it is possible to get patients out of bed and walking without other support very shortly after amputation. When the wound is clean, weight-bearing may be begun at the end of two to three weeks. In the writer's experience the time has often been less. Only serious complications should prolong it more than four weeks. Crutches delay progress and should not be allowed. When support is necessary, canes suffice and are not productive of bad habits. There is no pain when the apparatus is properly designed and fitted, other than moderate soreness of the bony prominences until they become accustomed to pressure.

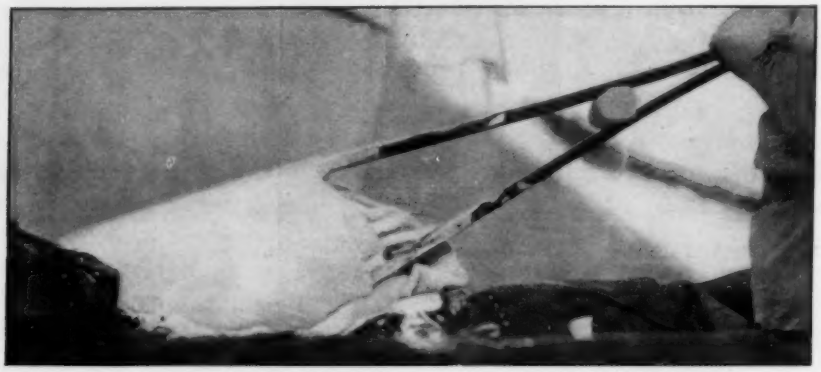
I.

Thigh peg leg. Stump covered with stockinette and cardboard cuff at end. Crutch frame being applied for preliminary fitting.

Because of this, however, and also because of the great muscular weakness, use should be begun gradually. At first the patient is encouraged to take a few steps supported by attendants. Later, as he becomes stronger, he may push a chair about the room until he has obtained sufficient confidence to walk unaided or with a cane. Short and frequent periods of exertion with long intervals of rest are better than prolonged efforts and over-fatigue. During the first few days the patient is timid and discouraged and it is essential that the surgeon should maintain close supervision in order to give the patient confidence and stimulate him to further effort. The ability to walk is usually acquired within a week, and thereafter progress is rapid. Little attention is required from the surgeon beyond changing the

II.

Thigh peg leg. Plaster has been applied to stump while traction was being exerted on the long end of the stockinette. Upper ends of the crutch frame have been covered with plaster ready for incorporation in the cast.



III.

Thigh peg leg. Cast finished. Note roller bandage in fork of crutch to prevent it from springing together and indenting the plaster.

socket when it becomes too large, and restraining the patient from acquiring his permanent artificial limb too early. The use of the temporary prosthesis is continued until the permanent limb has been obtained.

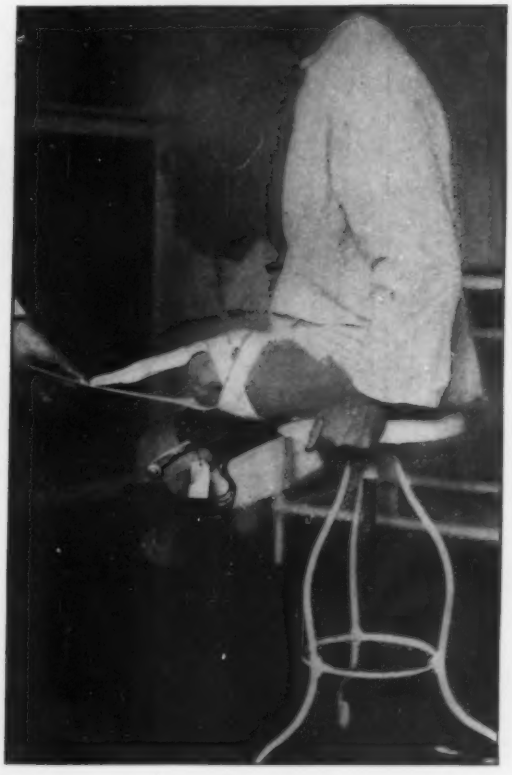
The benefits derived from this method of treatment are varied and may be considered as either physiologic, economic, or psychologic.

I. *Physiologic.* The results may be noted here as they affect first the wound and second the stump.

1. Effect on the wound. Following amputation there is always marked edema of the stump, chiefly noticeable about the wound or distal portion. Wound healing is notoriously slow and sinuses often

IV.

Thigh peg leg. Cast dried, trimmed, and applied.



V.

Application of traction to thigh stump to protect wound when pressure is borne. The ends of the straps are pulled down and buckled tightly to the lower end of the peg leg.

persist for a surprisingly long period. This condition is due to circulatory stasis and may be partially relieved by elevation of the part, massage, and tight bandaging. Active weight-bearing in a temporary limb with carefully fitted socket gives far more effective stump compression, however, than the most carefully applied bandage, and the alternate application and withdrawal of pressure in walking constitutes one of the best forms of massage. In addition, active use of the stump restores the conditions necessary for normal functioning of the circulation. It is certain that with this method of treatment the edema quickly disappears, the circulation becomes normal, and wounds and sluggish sinuses quickly take on a healthy appearance and heal rapidly.

VI.

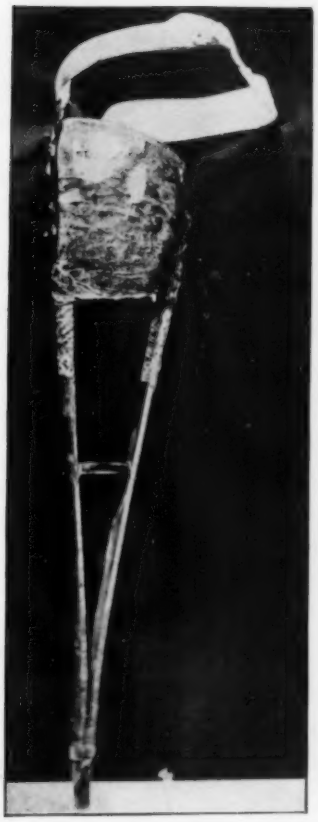
Front view of thigh peg leg for long stump. Note suspender.

VII.

Same as Fig. VI, rear view. The cast has been varnished with shellac.

Special measures must be taken to protect the wounds in certain cases, particularly thigh amputations where the conical shape of the socket tends to crowd the soft parts up from the end of the bone and thus produce possible separation of the flaps. This accident can always be prevented by the application of traction and has never happened in the writer's experience. Broad adhesive straps with tapes are applied to the soft parts of the stump and the tapes passed down through the open end of the socket and buckled tightly to the lower portion of the apparatus in such position as to exert downward pull on the parts about the wound and protect it. These traction strips serve also to fix the leg to the stump and may be used in lieu of other form of suspenders.

The presence of an open wound at the end of the stump is not a contraindication to early weight-bearing. Frequently during the war cases of amputation by the no-flap or guillotine method were fitted

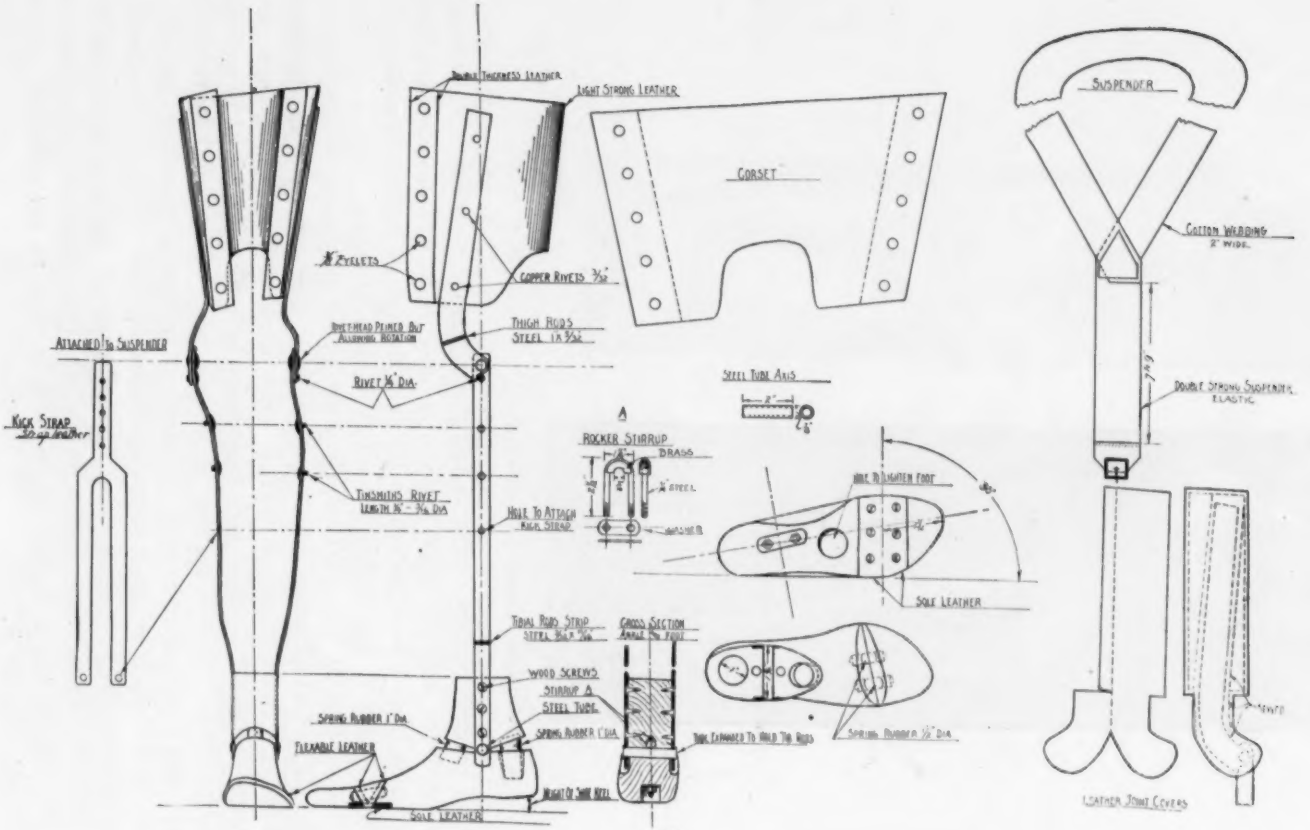


VIII.

Peg leg for short thigh stump, showing the T side bar and pelvic band. A suspender is also used, as shown in Fig. VI.

with temporary legs during a fairly early stage of their convalescence. They were able to walk without pain and it was noted that their wounds healed more rapidly with this method of treatment than without. Traction was always provided in such cases.

Improvement has particularly been noted following weight-bearing in old infected amputation stumps with localized osteomyelitis and sinuses. Such cases ordinarily drag along many months and are often subjected to secondary operations before active use of the stump is allowed. Weight-bearing after the acute infection has subsided hastens the separation and discharge of sequestra, improves the circulation of the part, and favorably influences the course of the disease in the majority of such cases. Backing up of the discharge and abscess formation occasionally compel the temporary abandonment of the method, but it should be resumed as soon as the condition of the wound permits it.



IX.

Diagram showing construction of skeleton leg for below-knee amputation.

X.

Below-knee leg. The frame is fitted and the side bars bent to conform to the shape of the stump.

2. Effect on the stump. In order to understand the effect on the stump of treatment by early weight-bearing, it is first necessary to consider the changes that should normally take place in it, following amputation. The operation deprives the larger part of the muscles in the sectioned limb of their insertion. Suture across the end of the bone of the groups antagonistic to each other is useful in preventing retraction, but will only preserve function in the relatively few muscles that originate above the proximal joint. The remainder no longer have work to perform and therefore atrophy, with resulting decrease in the stump diameter. In general, the longer the stump the greater the amount of atrophy, because the muscles arising from

XI.
Below-knee leg. The stump is covered with stockinette and the end protected with a pasteboard cuff. Traction is maintained on the stockinette.

the next higher bone segment are usually inserted in the stump close to the articulation. Another factor in producing stump shrinkage is the pressure of the socket of the artificial limb against the soft parts. This causes atrophy of the subcutaneous and intramuscular fat tissue and very considerable change in size. A stump that has been used actively for several years is often smaller by half than the normal limb.

From this it may be seen that stump shrinkage is entirely normal, that it is in part physiologic and in part due to weight-bearing. From the standpoint of function it is greatly desirable because the artificial limb can obtain a much better grip on an atrophied than a fat stump, with resulting increase in stability and leverage power.

Normal stump shrinkage is interfered with by the usual methods of treatment or, rather, lack of treatment. When a patient is allowed about on crutches without apparatus fitted to utilize the stump, the dependent position of the latter greatly favors an increase of the venous congestion and circulatory stasis produced by the operation. Instead of shrinkage in size there is increase in size on account of edema. Only active use can produce complete disappearance of the

XII.

Below-knee leg. Plaster is applied, covering the stump from its end to the middle of the patella.

swelling and the longer it persists the more difficult it is to bring about restoration of the normal circulation. With time there is absorption of some of the exudate, with increase in the amount of fibrous tissue. But the stump still remains large because, not serving any other useful purpose, Nature utilizes it as a convenient storehouse for fat just as she does any other inactive part of the body.

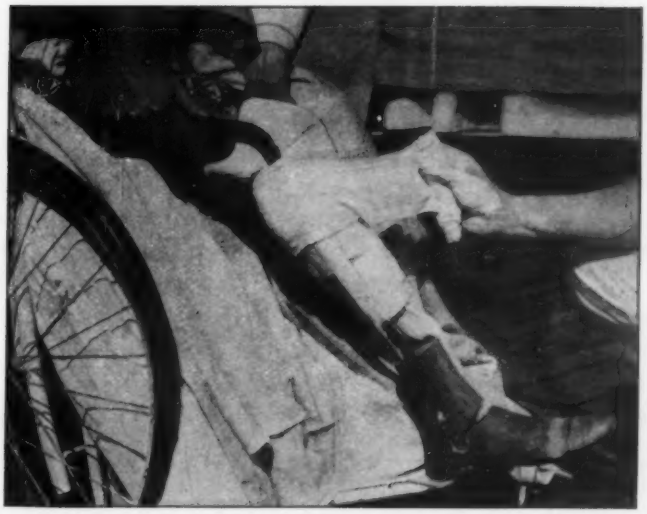
In such a stump nothing will produce shrinkage but active weight-bearing in an artificial limb. Tight bandaging or the use of laced leather "shrinkers," to be obtained of artificial limb makers, will help but will not furnish a solution. Furthermore, shrinkage will occur only in so far as the socket of the artificial limb remains tight enough to cause firm, even compression of the stump. This inevitably entails the changing of the socket two or three times during the process of evolution. On the other hand, this shrinkage does not go on indefinitely and, sooner or later, the length of time depending upon how soon weight-bearing is begun, the moment arrives when further decrease in size does not occur and the stump has reached the stage of complete evolution.

It is customary in present practice to wait three to six months after the amputation before beginning weight-bearing. The permanent type of limb is then fitted without any preliminary treatment to prepare the stump for its use. The stump under such conditions is fat, boggy and sensitive; the muscles which should activate it are atrophied and powerless, and important limitation of joint motion is commonly present. On the other hand, the leg used is relatively heavy and difficult to control. Close fit, freedom from pain, muscular strength, good coördination, and full range of joint motion are essential to its proper use. Learning to walk with an articulated limb is not easy at best; under the above conditions it becomes almost impossible.

In England and France during the first two years of the war it was impossible to supply artificial limbs in quantity sufficient to meet the demand. The great majority of the amputation patients had to wait many months before receiving them. During this period they went about on crutches without treatment, as it was before the possibility of using simpler forms of apparatus had been recognized. The condition of these men was lamentable indeed when they were finally examined for the fitting of their artificial limbs. The vast majority presented fat, congested stumps with powerless muscles and serious joint contractures. Practically all of them had to go back to the hospital for long periods of treatment before the limbs could be fitted. Many had to undergo serious operation for the correction of joint deformity. All made very slow progress and many never succeeded in learning to walk.

That such cases are very frequent in the surgery of peace, where the surgical supervision of the patient so commonly ends when wound healing has been obtained, is borne out by the cases seen by the writer in hospital and private practice. The application of some temporary apparatus such as described later, which permits weight-bearing soon after the amputation, hastens stump shrinkage, prevents congestion and edema, maintains tone and strength in the muscles which control the stump, and by normal use of the joints prevents limitation of motion.

II. *Economic.* The economic factor is of no small importance. Early weight-bearing reduces the period of convalescence by at least one-half. Convalescence ends when maximum functional restoration has been obtained. In the case of amputations of the lower limb this is represented not by the moment when the patient has been fitted with his permanent artificial limb, but when the stump has reached the



XIII.

Below-knee leg. The skeleton leg is applied, the side bars being covered with plaster and incorporated in the cast.

XIV.

The cast is finished and the upper margin of the socket is being marked out, in preparation for trimming.

stage of complete evolution and no further improvement in walking can be expected. By the methods commonly followed this is usually nine to twelve months, often longer. By the use of early weight-bearing it may be reduced to three to six months, seldom longer. Not only this, but the functional end result is better. When one considers the thousands of amputations performed in this country annually and multiplies this by the number of months of productive labor lost by old methods of treatment, figures quite fantastic in their economic importance are obtained.

Another advantage growing out of the use of the principle of early weight-bearing is more concrete, because it touches the pocketbook of the patient himself. The provisional apparatus used is very cheap. Change of socket, in order to keep pace with stump shrinkage, may be made at small expense. When maximum shrinkage has been obtained, the permanent limb is fitted and no further alteration is required.

On the other hand, when weight-bearing is only begun with the fitting of the permanent leg, stump shrinkage very quickly makes the socket too large for use. The only satisfactory method of altering a wooden socket is to make a new one. As this is a highly skilled operation it is also very costly, and as it must be repeated once or twice before the evolution of the stump is complete, this represents in its totality an expense that is usually but ill afforded.

III. *Psychologic.* Following the loss of a limb there is always a period of profound mental depression. The reaction to this usually takes one of two forms. Either the patient resigns himself to a life of invalidism and helplessness or he tries vigorously to resume his normal activities, fixing his hopes upon eventually becoming independent. The first means drifting, and if the pension is small may end in mendicancy. The second means maximum functional restoration, normal life, and economic freedom. The prolonged period of idleness, coupled with the consciousness of conspicuous deformity resulting from lack of treatment and the use of crutches, seriously favors the former, while early weight-bearing, even with a peg leg, by answering in a practical manner the question, "How am I going to walk?" gives a great impetus in the direction of normalcy.

Froelich of Nancy and Spitzy of Vienna share the credit of having been the first to apply the principle of early weight-bearing to the treatment of amputation cases. They used very simple forms of peg legs with plaster-of-Paris sockets. After them Martin at La Panne adopted the idea. He quickly saw its value and at the Ambulance

XV.
Below-knee leg. The leg finished, trimmed, and ready to wear.

XVI.
Temporary plaster peg leg for hip disarticulation.

de l'Ocean, extended its applications to all cases as routine. The French and English Medical Departments were by this time beginning to understand that the treatment of the amputation cases constituted a problem special to itself. After seeing the results of delayed weight-bearing it required but a little time for them to see the advantages of the new method. Special amputation centers were formed at which the cases were concentrated and provisional apparatus supplied. One and all adopted the principle of early weight-bearing, only the types of apparatus used differed. Difficulty was encountered in making the plaster-of-Paris sockets rapidly enough to take care of all the cases. Certain countries (Canada and Germany), therefore, developed appar-

XVII.
Mesial aspect of peg leg for hip disarticulation.

XVIII.
Syme amputation and temporary peg leg.

XIX.
Syme amputation. Patient using end weight-bearing in his peg leg.

atus capable of being constructed in quantity, in different sizes, so that the stump might be fitted as a shoe is fitted to the foot. These served a good purpose, but never met all the indications in the way the individually fitted plaster peg leg did.

In the American Expeditionary Force the plaster-of-Paris socket was used as a routine, but the apparatus incorporated into it was quite special and was developed only after a good deal of experiment. It was found possible to train men to make the plaster sockets under the supervision of a trained leg fitter, and nearly fifteen per cent. of the two thousand amputation cases involving the lower limb sent home from overseas were fitted with this type of apparatus before they left. The large number of the unfitted cases is explained by the fact that they were either bed cases, on account of complicating injuries, or stayed too short a time at the special centers to be fitted. It was recognized as useless to supply provisional legs unless the men could be kept a sufficient time to train them in their use.

In private and hospital practice for the last two years the writer has applied the principle of early weight-bearing in the treatment of all cases of amputation seen by him. The results have been even more gratifying than in the Army because individual attention can be given and it is less difficult to get the patient's coöperation and arouse his enthusiasm.

For thigh cases the simple peg leg made from a wooden crutch frame with plaster socket has been found best to meet the indications. It is extremely light and there is no difficult knee control to be learned, both advantages of great importance when the weak and sensitive condition of the stump at this early period after operation is considered. A knee-joint and foot put weight at a distance from the stump and this position multiplies in direct ratio to the length of the lever the force necessary to move it. On the other hand, most patients object to a peg leg for cosmetic reasons. It is necessary thoroughly to convince them of the benefit to be derived from its use before their coöperation can be obtained.

For below-the-knee amputations the regular Army model with articulated foot has been used. The presence of the foot does not complicate early weight-bearing in these cases as it does with thigh amputations. Only an ankle articulation is involved and the motion of this is blocked in such a manner that the presence of the foot really increases the stability of the leg. Added to this is the great advantage that the patient's deformity is completely masked by the apparatus. The patient walks with scarcely any limp and functionally is quickly able to do almost as much as when fitted with his permanent limb. The skeletal leg can be quickly made by any artificial leg maker at a cost of about fifteen dollars. The only measurements required are a tracing of the outline of the stump and thigh with the level of the knee-joint indicated, the length of the sound leg (from the knee to the sole), and the size of the shoe. In addition two circumferences of the thigh, above the knee and near the perineum, should be given.

METHOD OF MAKING THE PEG LEG FOR THIGH AMPUTATIONS.

A frame is first prepared by sawing off an ordinary wooden crutch at a height corresponding to the length of the leg from slightly below the perineum. The handle is removed and the cut ends of the crutch frame tapered down with a knife.

The patient may either lie on a table or stand. The latter position

XX.

Temporary peg legs used at first for below-knee amputations in the A. E. F.

is slightly more convenient for the surgeon. The stump is first covered with tubular stockinette, the upper end of which is pinned to the clothing and the lower end left long enough to hang below the stump. An assistant holds this end and makes downward traction throughout the operation so as to compress the edematous soft parts about the end of the stump and give it a conical shape. A strip of cardboard six inches wide and long enough to encircle the thigh is next applied to the end of the stump in the form of an overhanging cuff and fastened with adhesive strips. This serves as a form on which the lower end of the socket can be made and prevents pressure against the wound and surrounding tissues when weight is borne. Plaster bandages are then applied as in making an ordinary cast, the plaster being rubbed in well. Three to four bandages usually suffice. Special attention should be given to moulding the plaster about the ischial tuberosity, perineum, and gluteal fold. Care should also be taken that the stump is not abducted while waiting for the plaster to harden, otherwise space will be found to exist between the sockets and the trochanter when weight is borne.

The wooden crutch frame is now applied, the upper ends of the uprights being first covered with a few turns of plaster bandage so that they will adhere to the socket. The frame is held by an assistant, and pains must be taken to see that it points in the axis of the limb and that the side pieces lie at the center of the mesial and lateral aspects of the socket. The uprights may be prevented from springing into the socket and indenting it by first separating them to the desired width and holding them in this position by forcing a roller bandage into the fork of the crutch. The frame is now fixed to the socket by applying one or two more plaster bandages in a circular manner, a few turns being taken also around the wooden uprights at the bottom of the socket.

When the plaster has set, the line of the top of the socket is marked out. It extends in front from the top of the great trochanter obliquely downward to the perineum where it is notched out to avoid the descending ramus of the pubis which is always sensitive to pressure. It then ascends obliquely under the ischial tuberosity outward to the starting point at the trochanter. This line corresponds exactly in shape and angle to the ring of the well-known Thomas leg splint. The leg is now removed from the stump and the stockinette and cardboard pulled out from the inside of the socket. The top of the socket is trimmed with a sharp knife along the line previously marked and the cut edge of the plaster smoothed over by rubbing into it a little plaster paste.

The leg is now set aside to dry and later finished up by reinserting the wooden crutch handle between the wooden uprights below the socket and painting the latter with shellac to make it more durable. It is fitted for length and the end sawed off so that when weight is borne the leg is one-half inch shorter than the normal leg. A rubber tip is applied to the end.

The stump is covered with a woolen stump sock when the leg is worn, and this gives all the padding necessary. When the leg is put on, the end of the sock is seized from underneath through the open lower end of the socket and strong downward pull made as the stump is inserted. This secures relaxation of the soft parts about the wound and protects the latter from tension when weight is borne. If traction strips are used an opening is made in the end of the sock through which the tapes are passed and these are secured by buckles to the cross piece in the frame.

Suspension of the leg from the body is obtained by means of a two-inch webbing band with a piece of elastic inserted in the middle passing

beneath the cross piece in the leg and over the opposite shoulder, the two ends being buckled together in front.

If the amputation is above the middle third of the thigh the socket tends to slip off the stump when the leg is slightly abducted and causes instability. This may be largely prevented by riveting a "T" shaped iron extension to the top of the socket on its lateral surface and securing this to the pelvis by means of a webbing belt. The vertical limb of the iron should be jointed at the level of the top of the great trochanter in order to permit flexion and extension and should extend upward to just below the level of the anterior superior spine of the ilium. The horizontal limb of the iron is about five inches long and is curved to conform to the shape of the pelvis. It is this portion to which the belt is attached by rivets.

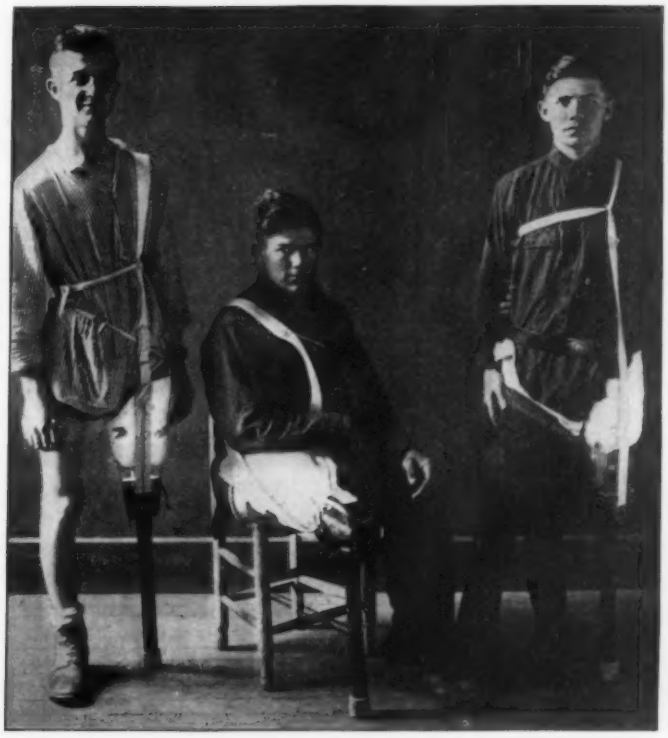
METHOD OF MAKING PROVISIONAL LEG FOR BELOW-THE-KNEE AMPUTATION.

As previously stated, the skeleton leg for this type of amputation is made by an artificial limb maker. It can usually be obained a week after placing the order. It is then fitted to the patient's stump and thigh to determine if the length is correct and the iron side bars properly bent to conform to the outline of the limb. The side pieces are sufficiently malleable so that changes can be made if necessary without special tools or skill.

If it is not possible to secure a provisional leg of the type described, one may substitute a simple form of peg leg. In this case malleable strap iron is cut to the proper length and bent to the shape of the stump. Two pieces, one on the lateral and one on the mesial side of the stump, are used as uprights, and after the socket has been made, a wooden peg is fitted between their protruding lower ends and fastened with screws.

The application of the plaster is most easily made with the patient seated. The stump is covered with the stockinette and if the end is bulbous, traction must be made as in the thigh cases by an assistant to compress and pull down the soft parts. The end of the stump is likewise protected from the direct pressure of the socket by a circular cuff of cardboard. Pressure of the socket on the external popliteal nerve lying on the head of the fibula is apt to be painful and may be prevented by fixing a small felt pad in this region with a strip of adhesive plaster.

With the knee extended, two to three plaster bandages are now applied covering the stump in a circular manner and extending from the middle of the patella to the bottom of the pasteboard cuff. The plaster should be carefully moulded about the upper end of the tibia as most of the



XXI.

Temporary peg legs with lock knee joint, permitting flexion when sitting.

weight is transmitted to the socket here. When the plaster has hardened, the skeleton leg is applied and the upper end held by lacing the thigh corset. The lower end is held by an assistant who also steadies the extremity of the stump by holding the loose end of the stockinette. Care must be taken that the iron frame is in the axis of the stump, that the joints for the knee are centered on a line with the middle of the patella, and that the tip of the wooden foot is in line with the center of the patella and the anterior superior spine of the ilium. If any space exists between the side bars and the previously applied portion of the socket it should be filled with folded pieces of plaster bandage, so that the irons are everywhere in contact with the plaster surface. Two or three plaster bandages are now applied, solidly fixing the frame in place.

The line of the top of the socket is next marked out with a skin pencil. This line runs in front from the lateral surface of the joint line downward and under the lower border of the patella, then upward to the

XXII.

Group of soldier patients overseas, equipped with different types of legs.

joint line on the mesial aspect of the knee. Behind the knee it curves down and then goes up to the starting point, forming a hollow in the popliteal space, so that the top of the socket will not cut into the hamstring muscles when the knee is flexed.

When the plaster has set, the leg is removed from the stump, the upper edge of the socket trimmed with a sharp knife, and the cut edge smoothed over with plaster paste. The apparatus is then set aside to dry. Occasionally, when the iron frame has not been properly fitted, there is a tendency of the uprights to spring apart and deform the socket before the plaster has solidified. This may be avoided by winding bandage about the uprights just above their point of attachment to the wooden ankle piece.

During this period one must take the precaution to keep the stump tightly bandaged with elastic material, otherwise swelling may occur, and it would be difficult to get the leg on again. In this connection one should remember that it is much easier to pull the stump into the socket from below by reaching up and grasping the end of the sock, rather than push it in from above. The latter crowds the soft parts up from the extremity and this not only enlarges the stump but causes tension over the end of the bone and makes walking painful.

If the extremity of the stump is particularly bulbous it may prove impossible to withdraw it from the socket after making the leg. In that case one may split the plaster posteriorly and spring it apart until

sufficient room is obtained. The same procedure is used in inserting the stump, and the socket is then drawn together with buckle straps or bandage. With weight-bearing the terminal swelling quickly subsides and then a new socket may be made which does not require splitting.

Fixation of the leg to the body is secured by means of the leather corset which laces about the thigh, Other suspension is usually unnecessary. When required, a webbing band two inches wide is used, arranged in the form of a loop passing over the opposite shoulder and under the axilla of the affected side. The ends of the loop are fastened together in front near the groin and from their junction an elastic webbing band of the same width descends to be fastened to the front of the thigh corset or to the leg itself below the knee. If traction is required to protect the wound it may be obtained in the same way as with the thigh peg leg.

METHOD OF MAKING PROVISIONAL APPARATUS FOR SPECIAL TYPES OF AMPUTATION.

Disarticulation of the Hip.

The crutch peg leg is used with a plaster-of-paris socket shaped like the half of a basin. It encloses half of the pelvis and extends slightly above the anterior superior spine. It is moulded accurately to the bony contour and may be padded with felt. In it the patient sits as in a deep Mexican saddle.

The wooden crutch is cut so that one side piece is about three inches longer than the other. The long upright is fixed to the lateral surface of the socket while the short piece extends to the under surface in the region of the perineum. Fixation is secured by means of plaster bandages as with the apparatus previously described.

Suspension is obtained by means of a webbing strap passing under the plaster socket, buckling in front. A webbing belt fixes the socket to the pelvis and prevents lateral displacement.

Patients with this type of amputation learn to walk very well with a provisional peg leg. Not only is there comfort but good stability and power. Sitting is difficult but can be managed, and progress is so rapid that it is scarcely worth while to provide the necessary joints and unlocking device to allow flexion in sitting.

Syme Amputation.

A simple form of peg leg has been used in these cases and has proved of great value in developing the all-essential end weight-bearing ability

of the stump. A good Syme is so satisfactory that no pains should be spared in achieving this result.

A plaster cast is applied enclosing the stump to below the knee. Light iron side pieces are fixed in the plaster on the mesial and lateral surfaces, the ends projecting two inches below the bottom of the cast. An oval-shaped window is then cut out of the front of the plaster to allow the withdrawal of the stump with its enlarged distal portion.

After the cast has dried the projecting irons are drilled for the passage of screws, and a wooden block of the necessary length is fitted. Fixation of the cast to the stump is obtained by replacing in its opening the plaster door previously removed and fastening it with buckle straps or bandage.

The patient walks in this plaster peg at first with the weight distributed between the usual bearing surfaces and the end of the stump. Later, as sensitiveness disappears, felt pads are inserted at the bottom of the socket, and their thickness is gradually increased until the entire weight is borne on the end of the stump. The top portion of the socket may then be removed and the patient walks in this small plaster boot until the permanent type of limb is fitted.

Summary.

1. Experience gained during the war in the treatment of patients with amputations of the lower limb has shown that it is possible to get such patients out of bed without crutches and actively bearing weight in peg legs or simple forms of artificial limbs at a period two to three weeks after amputation.

2. Early weight-bearing is of great advantage to the patient because (*a*) It promotes healing of the wound by improving the circulation, and in cases with terminal localized osteomyelitis favors the separation and spontaneous discharge of sequestra. (*b*) It hastens stump shrinkage and prevents muscle atrophy and the development of joint contractures. (*c*) It favorably influences the patient's morale. (*d*) It greatly shortens the period until the permanent artificial limb can be fitted and reduces the need of frequent alterations in the socket, and thereby much expense to the patient.

3. Provisional apparatus to secure early weight-bearing may be made to best advantage of simple materials, in the use of which the surgeon is already skilled.

4. With understanding of the advantages of early weight-bearing in the treatment of amputations of the lower limb, and of the little difficulty involved in its application, the method should be universally applied.

REPORT OF THE ORTHOPÆDIC EXAMINATION OF 1393 FRESHMEN AT YALE UNIVERSITY.

ROBERT J. COOK, M.D., NEW HAVEN, CONN.

In the past two years as Orthopædic Surgeon to the Department of University Health of Yale University, I have been privileged to examine, in the two entering classes of 1923 and 1924, a total of 1393 men.

A university such as Yale draws a selected group of men, who come from families where no little attention is paid to the physical welfare of the children. Furthermore, in the case of the larger number of men, considerable interest has been taken in their athletic development during the years of their preparatory schooling. These young men, therefore, certainly show a physical development as high or probably higher than any other group selected at random. The purpose of this survey has been to detect the possible correctible deformities, any defects in posture or body carriage, or any evidence of faulty development at a period when there is still time to correct them before the developmental period of the individual is past.

While the object of this examination has been to find those individuals who have some body defect and to undertake its correction, it must be kept in mind that at the same time this survey, including as it does all the students of the entering class, offers an excellent opportunity to

determine, from a group of so-called normal physical men, the percentage which have some postural or bodily mechanical defect. The examination of such a group of men affords us insight into the incidence of the minor as well as of the major body defects.

This report is a study of the postural or the body mechanical condition of a group of men in transit from preparatory schools to college life. The majority have had considerable attention given to their athletic development, but few, except those entering from military schools or those recently discharged from the army, have had their attention drawn to the mechanical set-up of their body. Instead, almost all have been under the instruction and care of individuals whose object was directed entirely to the development of muscular strength or athletic skill, and not to the correction of the abnormalities in the postural set-up or the mechanical relationship of the several component body parts.

It seems desirable to urge the correction of such faulty body attitude as round shoulders, round and hollow backs, lateral curvatures of the spine, flat chest, prominent abdomen, and weak feet. Such corrective work among college men, when directed either toward improving existing mechanical faults of the body or toward preventing those likely to occur, aside from improving the physical appearance of the man, should improve the efficiency and general health of the individual throughout life.

The orthopædic examinations were conducted in conjunction with the mensuration examinations given to the students by the Director of the Gymnasium. During the first year, individuals needing special work were discussed with him and placed under his supervision to carry out the necessary corrective exercises, but for the men of the class of 1924 the Director of the Gymnasium has designated a man who gives his entire time to corrective work. Those who needed such work were formed into small classes, varying from 10 to 12, and in this way we have been able to give them intensive training leading to the correction of their individual body defect—a marked improvement over the previous general gymnastic instruction.

As may be seen from the record inserted below, the age of the individual was obtained; he was questioned about bone and joint injuries, foot trouble, backache, his past athletic work, and his future athletic intentions. The routine orthopædic examination follows:

Name ..... Class .... Age ..... Date .....
Athletics in preparatory school ..... In Yale .....
Describe any bone or joint injury .... any backache or back injury .....
Any trouble with your feet ..... any muscle, tendon, ligament or nerve injury .....

Fill in Above. Do Not Write Below This Line. Use Back of Card If Necessary.

Abnormalities of head.....
SPINE. Deviation, none, right, left ...
Antero-posterior curvature .....
Kyphosis: 0, 1, 2, 3, 4; Lordosis: 0, 1, 2, 3, 4. .....
Kypho-lordosis: 0, 1, 2, 3, 4; Flat-back, 0, 1, 2, 3, 4 .....
Scoliosis .....
Postural: left, right, distance from perpendicular at .... spinous process ....
Left, right, shoulder, high: right, left, shoulder, back .... Lower extremity ....
Rotation, right, left .....
Structural: distance from perpendicular to left at .....
Spinous process: to right at .. sp. process .. Length .. right leg left ..
Left, right, shoulder, high: right left, shoulder, back .... FOOT .....
Rotation right ..... left .....
Pelvis level, tilted down on left, right ...
Neck forward .... degrees from perpendicular .....
Round shoulders: 0, 1, 2, 3, 4.....
Motion of spine: forward bend ....
rightside bend, left .....
Muscle spasm .. Paralysis back ....
Sacro-iliac joint .....
TREATMENT .....

Neck, chest: normal, flat, prominent, funnel, pigeon .....
Rib margin: level, flat, flaring.....
Right, left, side, forward; right, left, side, back .....
ABDOMEN: scaphoid, flat, prominent, protuberant .....
Upper extremity .....
None .....
Longitudinal arch: high, medium, low. absent .....
degrees .... Transverse arch, average, low, absent .....
Pronation: 0, 1, 2, 3, 4 .....
Flexibility; normal, fair, poor, absent.
backbend...Dorsiflexion .. degrees ..
Abnormalities of foot .....
Toes: hammer, hallux, valgus, absent.
Strength in pounds .....
.....right adduction left...
.....right abduction left
.....dorsal flexion plantar.
.....flexor long hallux
Foot tracing .....
Photograph .....
Summary .....

In order to record the condition of the individual at the time of the examination, photographs were taken. This photographic record, taken at the beginning and repeated at the end of the school year, shows the progress during the period of corrective work. In recording the class of 1923, a profile view was taken, showing the man in his natural standing position and in his best standing position. At the end of the

year it was found that many of the men who were given individual work could hold naturally and without constraint a poise the equal of their best possible standing position in the fall. The records of the class of 1924 were taken, one in profile and one posterior view. These photographs have been difficult to take in exact profile and have been difficult to repeat exactly, due to the swaying and shifting of the student after he has been posed. With the photograph and the record, the mechanics of the trunk were then studied with reference to kyphosis, lordosis, and flat back, conditions that are grouped in the tables under the topic of increased antero-posterior curvature, postural and structural scoliosis, flat chest and prominent abdomen. The grouping of kyphosis, lordosis, and kypho-lordosis has presented a considerable difficulty, since the presence of either kyphosis or lordosis is usually associated with the other. Consequently, the more marked defect is listed. The tilting of the pelvis was recorded in cases where present, and the length of the legs was taken to note the relation to scoliosis when it existed.

In the foot the varying heights of the longitudinal arch are recorded. Pronation is recorded in groups according to severity. Pain in the foot was investigated and was discovered to have been present in the past in some cases, but at the time of examination it was present in only a few; and in all cases, both past and present, in less than 10%. The flexibility of the foot was noted, the dorsiflexion of the foot, and the presence or absence of a short heel cord was recorded.

The shoulders and spinal curves were recorded as normal or grouped, according to the severity of their abnormality, as falling in the first, second, third, or fourth group, these groups being in sufficient number to record the seriousness of the defect.

The grouping of round shoulders, increase in the antero-posterior curvature of the spine, pronation of the feet, and height of the longitudinal arch of the foot, has been arbitrarily classified. While it would be desirable to classify each case, mathematically the slight variation of the several individuals in the group do not make it worth while at present.

These statistics are derived from the tabulation of the examination records of 1393 men, giving a group large enough so that it is felt that their presentation is worth while. In some of the smaller divisions, as backache and scoliosis with inequalities of the feet, it is not thought that there are enough cases from which conclusions can be drawn, and such tables are presented for what they may be worth. The results are tabulated as follows:

GENERAL TABLE.

	Percent
Bachache present	5.2
Backache absent	94.8
Spinal deviation—none	80.3
Spinal deviation—to the right	9.8
Spinal deviation—to the left	9.9
Round Shoulders—none	3.5
Round shoulders—first group	27.1
Round shoulders—second group	43.0
Round shoulders—third group	24.3
Round shoulders—fourth group	2.1
Normal antero-posterior curvature	44.1
Increased antero-posterior curvature, first group	19.0
Increased antero-posterior curvature, second group	24.7
Increased antero-posterior curvature, third group	10.6
Increased antero-posterior curvature, fourth group	1.6
Increased antero-posterior curvature, total	55.9
No lateral curvature	49.7
Postural scoliosis to the left	39.1
Postural scoliosis to the right	1.2
Structural scoliosis	10.0
Scoliosis, total	50.3
Scoliosis and increased antero-posterior curve combined	34.0
Normal spinal curvature	24.8
Chest normal	43.7
Chest flat	56.0
Pigeon breast	0.1
Funnel breast	0.2
Abdomen prominent	41.7
Abdomen, normal contour	58.3
Legs—equal length	85.4
Leg—right short	0.8
Leg—left short	13.8
Pelvis level	83.1
Pelvis—right side low	0.8
Pelvis—left side low	16.1
Foot trouble, past and present	7.2%
Pronation of feet .. none	17.9
Pronation of feet .. first group	42.3
Pronation of feet .. second group	29.5
Pronation of feet .. third group	9.8
Pronation of feet .. fourth group	0.5
Longitudinal arch high	5.6
Longitudinal arch medium	58.3
Longitudinal arch low	35.8
Longitudinal arch gone	0.3
Dorsiflexion of foot .. right angle or less	3.0
Dorsiflexion of foot .. 5°	13.9
Dorsiflexion of foot .. 10°	62.3
Dorsiflexion of foot .. 15°	20.8
Short Tendo Achillis	3.0
Flexibility of foot, normal	90.0
Flexibility of foot, limited	10.0

The forward droop or rounding of the shoulders has been recorded separately from the curvature of the spine, because, while frequently occurring together in relatively equal degree, there are many cases in which the two are dissociated. The shoulder girdle does not follow the contour of the chest wall in a similar manner in all cases; in some, as kyphosis increases and the chest wall flattens, the shoulder seems to be carried straight forward, while in other cases the shoulder seems to follow around on the lateral and upper side of the chest wall; in the first instance, the posterior aspect of the scapula slopes directly backward, while in the second instance it will be found sloping laterally as well as posteriorly.

The deviation of the spinal column at the level of the seventh cervical vertebra to the right or left of a plumb-line passing over the cleft of the buttocks was recorded. Such deviation occurs in cases in which no scoliosis exists, though it is usually associated with it. It is of interest to note that approximately 20% showed a spinal deviation under the above definition, while about 50% showed some type of scoliosis.

The scoliosis, postural or structural, when present, was recorded at the level or levels where the curve was the greatest. The motions of the spine, in cases of scoliosis, as a rule, were very slightly limited in bending against the convexity of the curve. This may be due to the rather slight curvatures, and to the physical activity of the individual. In the more marked cases of increase in the antero-posterior curvature, a moderate amount of stiffening of the spine has been noted.

Chests varied from normal to the usual grades of flatness. It is found that a flat chest, while usually associated with an increase in the antero-posterior curvature of the spine, was occasionally found among those having an approximately normal spinal contour.

Abdomens among these students are usually full, some are scaphoid, and a few are beginning to protrude.

If one glances through the general table, he cannot fail to be impressed with the low percentage of normal students. But 3.5% had no rounding of the shoulders; but 44.1% have a normal antero-posterior curvature; but 49.7% have no scoliosis; while only 24.8% have a normal spinal contour. The chest is normal in 43.7% of cases, while in over half it is flattened to some extent. Of interest in the feet is the fact that but 7.2% have had foot trouble. Less than one-fifth of this group have no pronation of the feet. The height of the longitudinal arch is satisfactory in the majority of cases; in fact, in only .3% of the cases was the arch found to be gone. Dorsiflexion of the foot is limited to a right

angle or less in but 3% of the cases, while the flexibility of the foot is free in 90% of cases. In general, the defects are those of poor trunk posture, carrying of the head and neck too far forward, rounding of the shoulders, increase in the antero-posterior curvature and lateral curvature of the spine, flat chest, prominent abdomen, pronation of the feet, and, in some cases, relaxed ligaments and muscles of the feet.

A topical study of the more interesting subjects of the general table is of interest. If we consider the trunk first, we find that 5.2% gave a history of backache, of which 1.9% gave physical exertion as the exciting cause; .6% were associated with disease, while in 2.7% no cause is known for the existence of the complaint.

BACKACHE.

Thirty-one of these cases of backache gave as a cause of their backache exertion in either work or sport. In five cases we find that backache has been associated with rheumatism, cardiac deficiency, lumbago, or an old empyema scar. Thirty-six of these cases had backache, but could give no reason for it. They complained of discomfort in the back, of a tired feeling or of pain in the small of the back, or in the thoracic region. The total number of these cases of backache is seventy-two.

Dr. Brown (*Am. Jour. of Orth. Surg.*, Vol. xv, No. 11, pp. 774-787), in his report on the examination of Harvard freshmen, found that 15.1% complained of backache, and that these men were in the group bearing a notably poor posture. In the Yale examination, 5.2% complained of backache; and it is of interest to note that backache, among athletes or those accustomed to work (in which cases the injury could be traced), is found in the majority of cases among the half of the class who have a relatively good posture, while those individuals who could give no reason for backache were found to be classed more frequently in the half of the class having a relatively poorer posture.

Of the thirty-one cases in which backache has come on following exertion, strain or trauma, eight fall into the first group, fifteen in the second, five in the third, and one in the fourth group of round shoulders: the shoulders and antero-posterior curvature of the spine are normal in two, and nine cases, respectively, while ten cases fall into the first group, seven into the second group, three in the third group, and two in the fourth group of increase in the antero-posterior curvature of the spine; in twenty-three cases scoliosis is present, while in thirteen cases scoliosis and an increase in the antero-posterior curvature are combined. In this group of traumatic backache several have received the primary injury in football, others have either strained or sprained their backs

while working; in single cases the injury was from a fall, from diving, and from a machine shop accident in which the individual was struck by machinery. It is of interest to note in these cases of traumatic backache that while the discomfort is not severe, it is lasting; further, that in these cases the postures in general are fairly good. Note that the round shoulders and the increases in the antero-posterior curvature are in the milder groups mainly; the scoliosis, though present in a large number of cases, is usually of the postural type. One thing that may be worth noting is that these back injuries, at the time they were received, were treated rather lightly or not at all, and this may, in some cases, explain their continuation to the present time.

There are five cases associated with disease,—one of rheumatism, two of cardiac disease, one of lumbago, and one with Pott's disease. The postural changes in this group suggest little.

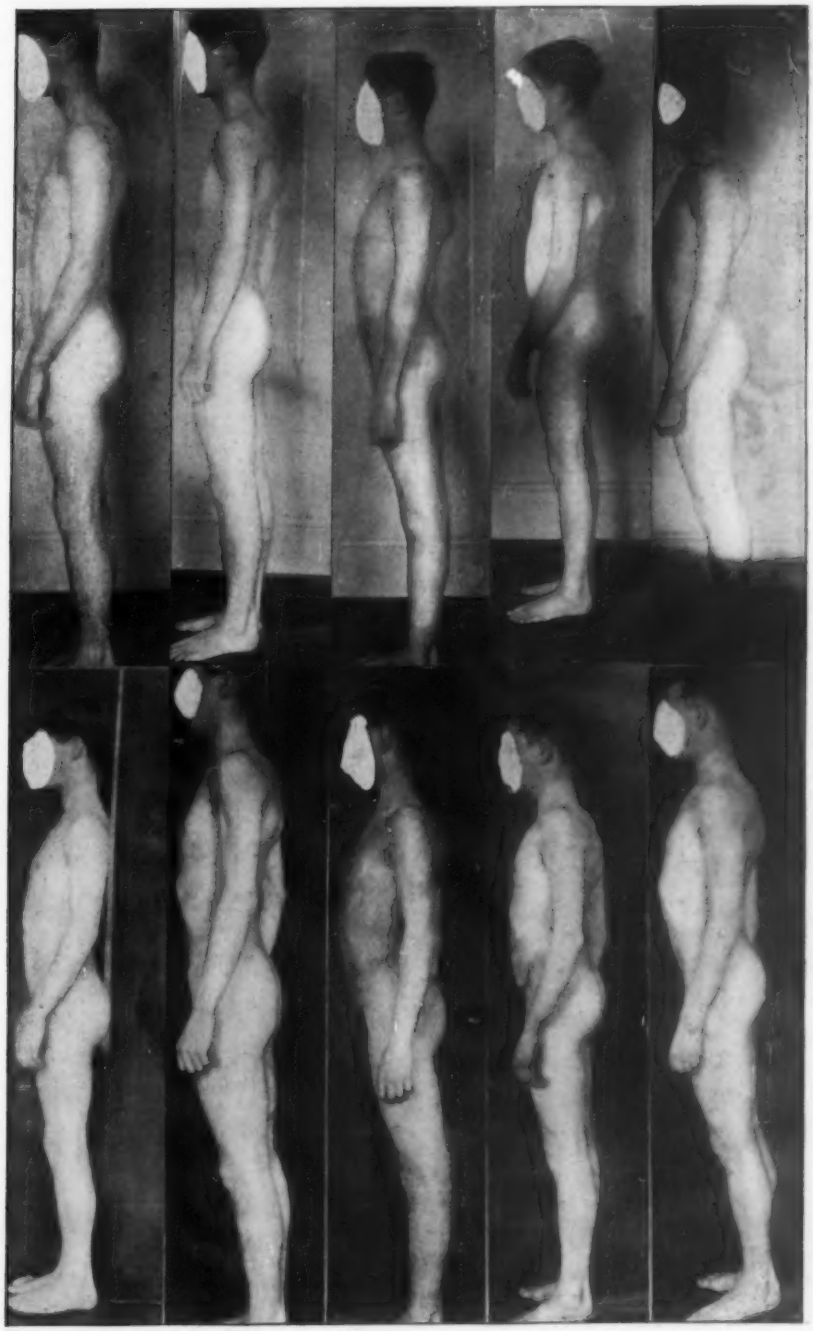
Of the cases in which no known cause is given for backache, there are thirty-six. Among these there is a deviation of the spinal column from the vertical in six cases. The first degree of round shoulders occurs in five cases, the second and the third in fourteen each, and the fourth degree in three cases. As regards the increase in the antero-posterior curvature of the spine, it may be said to be but moderately accentuated. Postural scoliosis occurs seventeen times and structural scoliosis five times. Twenty-five cases have flat chests and nineteen have prominent abdomens. The pelvis tilts in six cases, a short leg is present in three. Pronation of the feet is present in the first degree eighteen times, in the second degree eleven times, and in the third degree five times. In this group with unexplained backache, foot trouble had been complained of in the past in but three in the total of thirty-six cases.

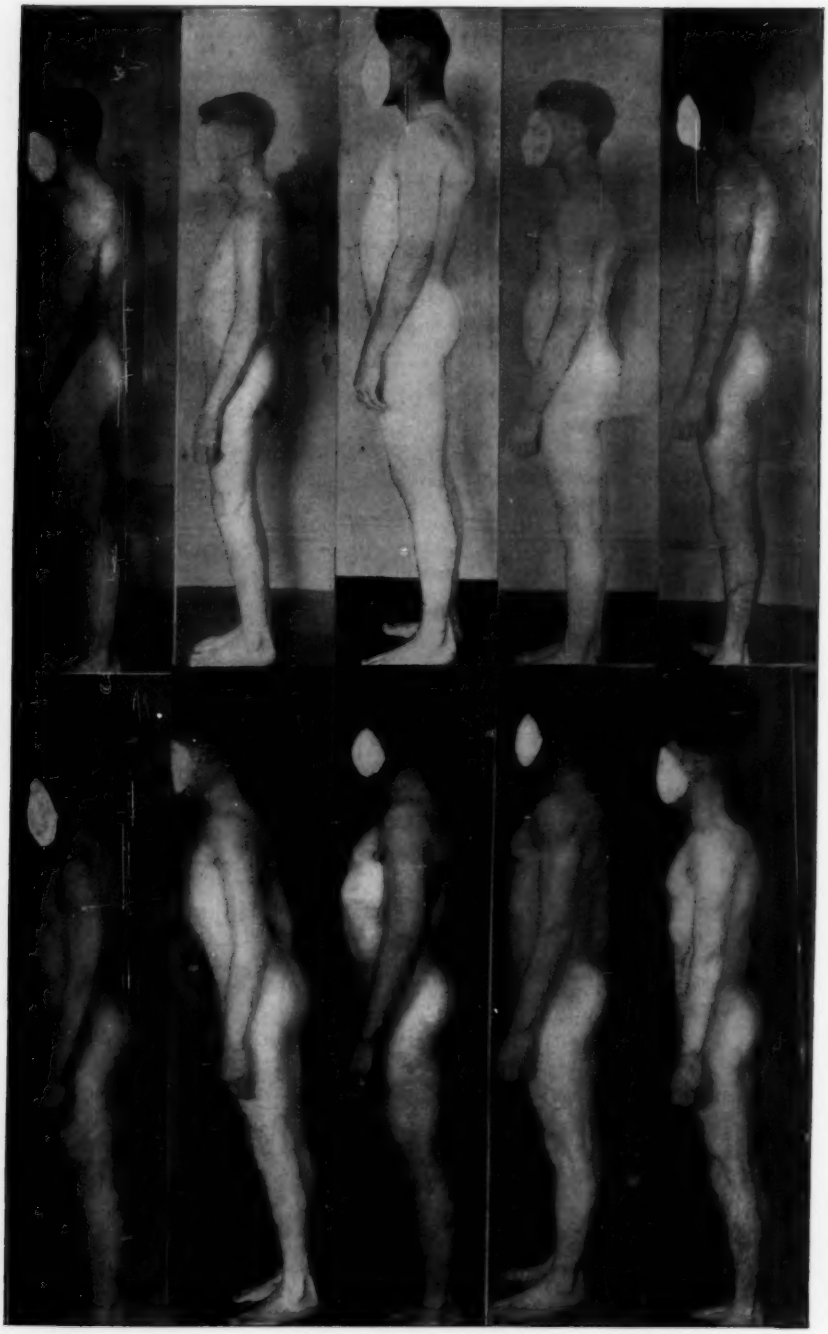
BACKACHE	5.2%	Deviation of Spine	ROUND Shoulders Group					Increased Antero-posterior Curvature Group					Flat chest	Prominent Abdomen	Scoliosis		Pelvis tilted	Short leg	Pronation Group				
			None	1	2	3	4	None	1	2	3	4			Postural	Structural			None	1	2	3	4
From work	1.9%	1.0	0.1	0.5	0.9	0.3	0.1	0.5	0.4	0.6	0.3	0.1	1.2	1.1	1.0	0.2	0.3	0.1	0.2	0.9	0.7	0.1	0.0
Associated with Disease	0.6%	0.1	0.1	0.1	0.2	0.2	0.0	0.2	0.2	0.1	0.0	0.1	0.4	0.4	0.3	0.1	0.2	0.1	0.1	0.3	0.1	0.1	0.0
No known cause	2.7%	0.5	0.1	0.4	1.0	1.0	0.2	0.8	0.6	0.5	0.4	0.4	1.6	1.1	1.4	0.3	0.8	0.3	0.2	1.4	0.8	0.3	0.0

The following three plates show photographs of men taking correctional work.

The upper row shows the man in his natural standing position in the Fall; the lower row shows the man in his natural standing position in the Spring, following a course of correctional training.

In column the photographs are of the same man.





In the group of backaches, taken as a whole, it is to be noted that round shoulders of a mild degree occur in the group of traumatic backache and of a more marked degree in the backache of unexplainable origin. This same statement would hold true, to a slightly less degree, when applied to increase in the antero-posterior curvature of the spine. The flat chest of individual predominates. Scoliosis is present in but little less than one-half of the cases. Pronation of the feet is present usually in the milder degrees, though it is found that it occurs more commonly among those cases in which the backache is unexplained. Generalizing, we may say that the body posture or mechanics is not as good in the group of unexplained backaches as among those in which trauma is a factor.

ROUND SHOULDERS.

Round shoulders are found either with or without increase of the antero-posterior curvature of the spine. In 2.7% of the total cases normal shoulders occur with a normal antero-posterior curvature of the spine, while in 41.4%, in which the antero-posterior curvature of the spine is normal, the occurrence of round shoulders in varying degree is noted, being more common among the milder grades. In .8% of the cases in which the antero-posterior curvature of the spine was increased, the shoulders remained normal. In the cases in which both round shoulders and kyphosis occur, the round shoulders show a greater degree of severity, proportionately, than does the kyphosis. When compared with lateral curvature of the spine, round shoulders are not found in proportion to the type of severity of scoliosis, though both commonly occur together. The frequency of flatness of the chest parallels the rounding of the shoulders, as it also does the increased antero-posterior curvature of the spine, on which it seems the more dependent. The prominence of the abdomen increases proportionately with the severity of the round shoulders, though its presence is found in more true association with an accentuation of the antero-posterior spinal curvature, and a flattened chest.

As pointed out by Bradford (*Orth. Trans.*, Vol. x, p. 162), and by Hasebrook (*Zeitschr. f. orth. Chir.*, xii, p. 612), a shortening of the soft parts anteriorly, as well as a relaxation of the posterior muscles moving the shoulder girdle, is usually found.

	Round Shoulders		Backache	Deviation spinal column	Increased Antero-Posterior Curvature					Scoliosis			Flat Chest		Prominent Abdomen		Pronation				
		%				Group												Group			
					None	1	2	3	4	Postural	Structural	None	Present	Absent	Present	Absent	None	1	2	3	4
None	3.5	0.3	0.4	2.7	0.4	0.2	0.1	0.1	1.0	0.3	2.2	0.7	2.8	0.8	2.7	0.8	1.5	0.9	0.3	0.0	
Group 1	27.1	1.0	6.2	17.5	6.6	2.4	0.6	0.0	11.2	2.7	13.2	6.3	16.6	12.1	15.0	4.7	12.3	7.8	2.3	0.0	
Group 2	43.0	2.1	6.0	29.3	9.5	12.3	1.8	0.1	16.4	2.9	21.7	22.0	21.0	18.0	25.0	7.4	18.7	13.2	3.5	0.2	
Group 3	24.3	1.5	5.0	5.2	3.2	9.4	7.4	0.5	8.9	3.8	11.6	15.7	8.6	10.3	14.0	4.8	8.7	6.9	3.6	0.5	
Group 4	2.1	0.3	0.1	0.0	0.1	0.4	0.7	0.9	0.8	0.3	1.0	1.9	0.2	0.5	1.6	0.2	0.6	0.9	0.3	0.1	

ANTERO-POSTERIOR CURVE OF THE SPINE.

The present-day idea of posture or body mechanics seems to depend largely upon the conception of the normal antero-posterior curvature of the spine. If the spine has a normal forward curve in the cervical region, a normal backward curve in the dorsal region, and a normal forward curvature again in the lumbar region, we feel fairly certain that the individual is carrying his head at the proper angle, that his shoulders are carried back, his chest forward, and that his abdominal wall is flat. On the other hand, if the individual has a dorsal kyphosis of any degree, we usually find it associated with an increase in the other regional spinal curves, with the head carried forward, the chest flattened, and the abdomen prominent or protuberant, while the rounding or forward droop of the shoulders is increased.

In this series of cases, 44.1% of the cases have an approximately normal antero-posterior spinal contour; but of this number only 2.7% have normal shoulders, while 41.4% have round shoulders of varying degree, thus showing that a normal antero-posterior curvature is not necessarily accompanied by shoulders normally carried; a flat chest was found in 17.4% in association with a normal spinal curvature, while the abdomen was prominent in 11.8% of the cases, and backache was complained of in 1.6% of the cases in this group. Of the remaining cases, the majority fall into the moderately marked groups of increased spinal curvature. Only 1.6% fall into the poorest group associated with the more marked degree of round shoulder.

Increased antero-posterior Curvature 55.9%	Percentage of cases	Round Shoulders					Flat Chest		Prominent Abdomen		Backache	
		Group										
		None	1	2	3	4	present	absent	present	absent	present	absent
Normal	44.1	2.7	17.3	20.3	3.8	0.0	17.4	26.7	11.8	32.3	1.5	42.6
Group 1	19.0	0.4	6.8	8.5	3.2	0.1	10.2	8.8	14.3	4.7	1.2	17.8
Group 2	24.7	0.2	2.4	12.3	9.4	0.4	13.4	11.3	10.3	14.4	1.2	23.5
Group 3	10.6	0.1	0.6	1.8	7.4	0.7	6.6	4.0	4.4	6.2	0.7	9.9
Group 4	1.6	0.1	0.0	0.1	0.5	0.9	1.0	0.6	0.9	0.7	0.6	1.0

SCOLIOSIS.

As regards scoliosis, 49.7% have no scoliosis, 1.2% have a right postural, and 39.1% a left postural scoliosis, while 10% have a structural scoliosis. Rounding of the shoulders is, of course, associated with scoliosis, both being evidence of body weakness; however, the presence of round shoulders in association with scoliosis does not occur in proportion to the type of scoliosis or its severity. It is to be noted that 31% have scoliosis, and increased antero-posterior curvature; that 24.8% have a normal spinal contour; that 24.9% have an increased antero-posterior curvature without scoliosis; that 19.3% have scoliosis alone.

Comparing the statistics given by Lovett (Lateral Curvature of the Spine—Blakiston, 1907), we find that of our cases of functional scoliosis 97% are to the left and 3% to the right, as against 90% and 10%, respectively, as cited by him. Luning and Schulthess (*Orthop. Chir.*, J. F. Lehmann, 1901) give the relationship of left functional scoliosis to the right as 5:1.

Estes (*Jour. A. M. A.*, Vol. 75, No. 21, p. 1411), in seven yearly examinations of the students at Lehigh, in five years of which the examination was done by the Physical Director of the Gymnasium, and in the two later years being done by himself, finds the percentage of scoliosis to vary from 9.5 to 43.6% in the seven different classes. This compares with 50.3% of the class here.

The relationship of the types of scoliosis as found by Estes were: Left total, 69.8%; right total, 12.6%; and structural, 17.5%. It is to be regretted that Estes could not have examined these several classes himself, since it is quite evident that the wide variation, as found by the Director of the Gymnasium (as low as 9.5%) and his own estimate (as high as 43.6%), represents wide divergencies of opinion as to what constitutes scoliosis.

The collected figures of Scholer, as given by Lovett, a total of 9483 cases, observed by eight men, show 37% of cases with scoliosis.

Scoliosis has usually been regarded as a disease of females, the relationship of cases in females to males being 4:1 (Whitman, *Orth. Surg.*, Lea & Febiger, 1919). These figures are probably based on clinical statistics, and as more girls than boys are usually brought to a clinic for correction of scoliosis, the difference may be explained. When,

Scoliosis 50.3%	None 49.7	Postural Right 1.2%	Postural Left 39.1%	Structural 10.0%
Backache	1.9	0.0	2.7	0.6
Deviation of spine-none	44.2	0.9	27.9	7.3
right	2.8	0.2	5.4	1.4
left	2.7	0.1	5.8	1.3
Round shoulders-none	2.2	0.0	1.0	0.3
group 1	13.2	0.2	11.0	2.7
group 2	21.7	0.5	17.9	2.9
group 3	11.6	0.4	8.5	3.8
group 4	1.0	0.1	0.7	0.3
Increased none	24.8	0.5	14.9	5.9
antero- group 1	6.8	0.3	10.6	1.3
posterior group 2	12.3	0.2	9.3	2.9
curvature group 3	4.9	0.2	3.9	1.6
group 4	0.9	0.0	0.4	0.3
Pelvis level	48.3	1.0	26.8	7.0
low on right side	0.1	0.2	0.1	0.4
low on left side	1.3	0.0	12.2	2.6
Flat chest	26.4	0.8	24.1	4.7
Prominent abdomen	15.3	0.7	22.1	3.6
Legs - equal length	49.0	1.0	26.6	8.8
right short	0.2	0.2	0.1	0.3
left short	0.5	0.0	12.4	0.9
Pronation - none	9.3	0.1	6.1	2.4
group 1	23.2	0.6	14.1	4.4
group 2	12.4	0.3	14.5	2.3
group 3	4.5	0.2	4.2	0.9
group 4	0.3	0.0	0.2	0.0
Arch-high	2.4	0.2	2.4	0.6
medium	28.3	0.7	24.0	5.3
low	18.8	0.3	12.6	4.1
gone	0.2	0.0	0.1	0.0

in a group of nearly 1400 men, one-half are found with scoliosis, it looks as if scoliosis occurred in men about as frequently as in women.

A short leg occurs in cases where no scoliosis is present in .7% of all cases. In right postural scoliosis, a short leg occurs in .2% of cases; in left postural, in 12.4% of cases on the left, and in one case on the right; while in structural scoliosis a short leg occurs in 1.2% of cases. With the idea that unequal pronation or unequal height of the arch of the foot might have some bearing on scoliosis, the results of these cases are tabulated below. It is of course probable that if one foot pronates more than its mate, or if the height of the longitudinal arch varies much, the pelvis will be tilted down to the affected side, and a scoliosis may be the result; on the other hand, it is possible to have a badly pronated foot or a lowered longitudinal arch compensate for shortening in the length of the opposite limb. As the table shows, we found inequalities of the feet in 5% of all cases, and in 3.7% of cases of scoliosis, in which, with a single exception, the lowered foot is on the side of the scoliosis in postural cases, and on the side of the lumbar curve in structural cases.

Scoliosis with Inequalities of Feet	%	Unilateral unequal pronation or inequality of height of longitudinal arch lower on		Length of Legs	
	5.0	right	left	equal	unequal
No scoliosis	1.3	0.4	0.9	1.2	0.1
Postural — left	2.8	0.1	2.7	2.8	0.0
right	0.4	0.4	0.1	0.4	0.0
Structural	0.5	0.1	0.4	0.5	0.0

FEET.

Very few cases gave a history of foot trouble, but this group of men is of an age and of a type of life where a considerable use of the foot is unnecessary. As college or preparatory school students, they are not called upon to walk more than four or six hours daily. Possibly this reason, as well as their youth, furnishes the explanation of their freedom from foot trouble. The great majority of them have a freely flexible foot. The relationship of pronation, height of longitudinal arch, and the degree of dorsiflexion of the foot are shown in the table. It may be worth noting that about one-fifth of these cases show no

pronation, while two-fifths show pronation of the first degree; that about 95% have an average arch, *i. e.*, either medium or low; and that the dorsiflexion in 80% is over 10 degrees.

In looking over the individual cases of foot trouble, moderate or unequal pronation, low arch, diminished flexibility of the foot, limitation of dorsiflexion, hallux valgus, hammer toes, anterior metatarsalgia, and warts on the sole of the foot were found. There are, to be sure, other cases in which no definite foot disability is evident, which have given the usual symptoms of foot strain.

Foot Table	Pronation					Longitudinal Arch				Dorsiflexion			
		Group											
	None	1	2	3	4	High	Medium	Low	Gone	Right Angle	5°	10°	15°
Backache	0.5	2.6	1.6	0.5	0.0	0.8	2.6	1.6	0.2	0.3	0.9	2.6	1.4
Foot trouble past-ankle	00.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1
arch	0.8	0.3	1.1	0.9	0.2	0.3	0.3	0.4	0.1	0.5	1.0	0.5	0.1
metatarsals	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
present-ankle	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.1
arch	0.2	0.8	1.1	1.0	0.1	0.1	1.6	1.8	0.1	0.2	0.8	1.8	0.7
metatarsals	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Pronation — none	17.9					2.7	13.1	2.1	0.0	1.2	2.7	9.8	4.2
group 1		42.3				2.2	28.5	11.5	0.1	0.4	4.7	29.1	8.1
group 2			29.5			0.6	13.4	15.5	0.0	0.8	4.4	18.2	6.1
group 3				9.8		0.1	3.2	6.4	0.1	0.6	1.9	5.0	2.3
group 4					0.5	0.0	0.1	0.3	0.1	0.0	0.2	0.2	0.1
Longitudinal arch-high	1.9	2.6	0.8	0.2	0.1	5.6				0.3	1.4	2.8	1.1
medium	14.0	27.6	13.4	3.2	0.1		58.3			1.4	8.2	36.8	11.9
low	2.0	12.0	15.3	6.3	0.2			35.8		1.2	4.2	22.7	7.7
gone	0.0	0.1	0.0	0.1	0.1				0.3	0.1	0.1	0.0	0.1
Dorsiflexion-right angle	1.2	0.4	0.9	0.5	0.0	0.3	1.4	1.2	0.1	3.0			
five degrees	2.7	4.6	4.6	2.0	0.0	1.2	8.3	4.4	0.0		13.9		
ten degrees	9.7	29.3	18.0	5.0	0.3	3.0	37.0	22.2	0.1			62.3	
fifteen degrees	4.3	8.0	6.0	2.3	0.2	1.1	11.6	8.0	0.1				20.8

TREATMENT.

The treatment of the body defects has been carried out in the gymnasium under supervision in classes of 10 or 12. The student has been shown his defect — whether round shoulders, abnormal spinal curve, flat chest, prominent abdomen, or weak feet. Following this, he has had demonstrated the improvement in physique when he assumes the correct bodily mechanical posture. After this, he has been given corrective exercises to overcome or improve his body defect.

Photographs have been of great help in pointing out to the individual his defect. The photograph taken in his natural standing position, when compared with the one taken in his best standing position, shows him the defect to be overcome, and these pictures repeated dur-

ing or at the end of his course in corrective training show him how much he has accomplished. The man has been urged to carry out these exercises both in the gymnasium and in his room. For weak feet muscle exercises have been given; the individual has been taught the more desirable way of walking; and, when necessary, alterations of shoes have been advised.

RESULTS.

With the help of the instruction in the gymnasium these men have been able definitely to improve their body posture. Should his case have fallen in the third group of round shoulders or in the third group of increased antero-posterior curvature he can improve his abnormality so that his case falls in the second or first group or, in some cases, within normal limits, but this position he is not able to hold naturally. However, when we study the photographs taken after he has undertaken to correct himself, following a course of corrective exercise, it is seen that he has so improved himself that, in many cases, that which was formerly his best corrected attitude has now become his normal way of carrying himself.

CONCLUSIONS.

Students entering college are at an age when bodily defects can be corrected. The type of defect is one which can be improved in practically all cases, and corrected in many. The improvement, as shown in the photographs, where there are present round shoulders, increase in the antero-posterior spinal curvature, flat chest, or prominent abdomen, is sufficient to urge that more time and effort be expended in this field of orthopædics.

Accurate records should be taken and kept which will show the value of this form of therapy.

The value of photography in showing to the student his physical defect is evident. By this means his posture can be accurately recorded more satisfactorily than by any other method.

ASTRAGALECTOMY AND BACKWARD DISPLACEMENT OF THE FOOT. AN INVESTIGATION OF ITS PRACTICAL RESULTS.* †

BY ARMITAGE WHITMAN, M.D., F.A.C.S., NEW YORK.

THE value of any operative procedure must be judged from three points of view—first, that of its originator; second, that of others who might be expected to possess sufficient skill properly to carry it out; and third, that of the subjects upon whom it has been practised.

It is conceded that many operations have given brilliant results in the hands of their originators, while the results when the same operation was performed by others have not been equally gratifying. Aside from the element of personal bias, this may be due to the exceptional skill of the operator or the exceptional difficulties of the operation. Finally, there is the unhappy result of the performance which theoretically was correct, but which practically the patient did not like. We may, therefore, legitimately require that to be judged successful an operation may be properly performed by one possessed of no extraordinary degree of skill, and that its result, if satisfactory to the surgeon, should at the time be appreciated by the patient.

Of all the operations at the Hospital for the Ruptured and Crippled for the relief of paralytic deformities of the foot, the one performed by far the most often is the Whitman operation — astragalectomy and backward displacement of the foot. It has gradually and steadily outnumbered arthrodesis, tendon transplantation, tendon implantation, etc.

Originally devised for the relief of paralytic talipes calcaneus, its usefulness has become so apparent that it is now employed in the treatment of paralytic valgus and varus, for dangle-foot, for club-foot, and

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†In preparing the following report upon end results of the Whitman operation, it was my intention to examine one hundred cases, taking twenty from each of the past five years. The work of tracing the cases proved so unexpectedly difficult, and the date for finishing my paper—April 28—gave me so little time, that I have been forced to base this report upon sixty cases only, twenty from 1919, and ten from each of the other four years. I hope later, for my own satisfaction, to complete the series of one hundred, but I am convinced that the present number presents a fair average from which to draw conclusions.

occasionally for tuberculosis and osteomyelitis. In this connection it is interesting to note in passing that Dr. Whitman's technique was described in almost identical detail by Dr. Chutro in his address before the American Orthopedic Association in 1919, in dealing with the proper treatment of war wounds of the ankle-joint. It has, then, finally become in one hospital the universal standby, and is looked upon as the operation that will succeed where all others have failed—that may be held in reserve for the relief of almost any paralytic deformity of the foot, and that will promise, even in the worst cases, a painless, stable, and fairly sightly foot.

Upon examining the hospital records and finding a striking preponderance in favor of one operation (see Table 1), one is naturally led to enquire the cause. One would hope to find this due solely to the excellence of the results following its use, but one is also bound to take into consideration ignorance of other procedures that may be as good or better; the force of insularity, or local, institutional or civic prejudice; the purely personal influence of the originator; or finally the strength of tradition.

I therefore determined to investigate the end-results of the operation by examining one hundred cases, twenty from each of the past five years, 1915, 1916, 1917, 1918, 1919. The cases were taken in order as they appeared on the operating record. If the first case in 1915 could not be traced, or refused to return, the twenty-first case was then sent for, and so on, thus obviating the possibility of the results being, as it were, hand picked. They were all taken from Dr. Whitman's service, but were by no means all done by him, as will be seen in the statistics.

As the operation was devised originally solely for the relief of talipes calcaneus, it might seem fair to confine a criticism of its results to that type alone, but as its application has been so widely expanded I decided to investigate an equally wide range of its results. As I was absent on military service from May, 1917, to February, 1919, I had no intimate personal connection with, or knowledge of any number of the cases, nor were they themselves, nor their parents, acquainted with me. They therefore had no hesitation in freely expressing their opinion of the result. As a number of the patients lived at a great distance, and it was obviously impossible for them to return, a questionnaire was included with the original letter, with the idea of getting from the replies no accurate technical information, but a fair idea of what the patients and patients' families thought of the results of their operative treatment. The replies to this form have been gratifying.

TABLE No. 1.

Year-	Tendon - Transplantation	Astragalectomy-Arthrodesis-	Gallie - Operation	Miscellaneous	
1897	1	5	4		
1898	11	2	5		
1899	55	11			
1900	12	6	1		
1901	22	3	2		
1902	31	13	16		
1903	32	13	43		
1904	13	13	14		
1905	14	9	22		
1906	21	12			
1907	5	18	25		
1908	1	14	19		
1909	4	13	17		
1910	13	37	18		
1911	8	35	7		
1912	12	44	4		
1913	21	54	9	2	
1914	22	80	21	4	
1915	46	100	16	21	
1916	73	92	2	48	Remodelling astragalus for calcaneo-varus- 11
1917	59	100	8	2	
1918	34	103	8	1	
1919	32	113	3		Osteotomy thru arch 5
Total-	542	890	274	78	16

Astragalectomies -- 890
All other procedures--910

Operations for the relief of paralytic deformities of the foot, performed at the Hospital for the Ruptured and Crippled since 1897, the year of introduction of the Whitman operation.

It will be seen from a study of the table of operations that the number of arthrodesis operations has been slowly and steadily decreasing. I may safely say that it is here the current impression that in young subjects, and particularly those suffering from paralysis, whose bones are notoriously soft, it is impossible to obtain a true bony ankylosis. A deceptive degree of stiffness may be evident for months after operation, and combined with other procedures, such as tendon transplantations, this stiffness may be utilized, and even prove sufficient to its subsidiary rôle. Corrective operations depending solely for their success upon the formation of a bony ankylosis have been observed to be failures. Indeed, one of the strongest bits of corroborative evidence lies in the results of the Whitman operation. Were bony ankylosis to be expected from removal of cartilage and the apposition of bleeding, bony surfaces, one would certainly find it in astragalectomy, where it is our custom to reshape both malleoli and insert them in beds prepared by removing sufficient cartilage and bone to permit of their snug reception. Their stability in this position is maintained by suture and by plaster of Paris. That it is the wide impression that such technique must result in ankylosis may be evidenced by the following quotations: *"Although it would seem that a sufficiently destructive removal of joint surfaces would surely result in anchylosis, the fact remains that skillful and experienced surgeons will *occasionally* fail to secure a stiff joint." Later, speaking of astragalectomy itself, *"because in the modified operation as performed in the Children's Hospital, Boston, an ankylosed ankle is not aimed at."

As a matter of fact, in not one of this series of cases examined has there been ankylosis at the ankle joint. The limitation of motion has been entirely dependent on the degree of backward displacement of the foot upon the leg, and failure of the operation has been due to too much motion rather than to stiffness.

The purposes for which the operation has been done are as follows:

1.—For calcaneus. The object here is to check deformity, to attain stability, to dispense with apparatus, and to provide a functionally passive foot with propulsive power.

2.—For dangle-foot. The object of the operation in this condition varies according to the degree of paralysis. If the weakness be chiefly

*R. W. Lovett. Treatment of Infantile Paralysis, p. 118, 2nd Edition, P. Blakiston's Son & Co., Philadelphia.

below the knee, the operation will provide a symmetrical extremity and enable the patient to discard apparatus. If the paralysis involves the entire extremity, the operation has frequently been done simply to give a stable foundation and to permit brace-wearing with comfort. Also in paralysis of the quadriceps extensor, when the resistance to dorsal flexion will lock the knee in extension and thereby assure stability of the limb.

3.—For advanced varus or valgus deformity. It has usually been done in this class after the failure of other operative procedures and is looked upon as a last resort. It should, as a rule, be combined with tendon transplantation.

It is thus evident that the result which we may expect from the operation will vary according to the class of case in which it was performed. In reviewing the series, I have, however, grouped them all together. To class a result successful I have required that dorsal flexion should be checked at a right angle, that there should be no appreciable lateral deformity when weight is borne, and that apparatus, when it is worn, should be worn with comfort. The opinion of the patient must also be satisfactory. There have been cases puzzling to classify: for example, in which the patient was satisfied with a degree of varus deformity, for which the surgeon would recommend correction (Case No. 22). In such cases the surgeon's opinion has been given the greater authority. In fact, as such research as this should be definitive, the emphasis throughout has been placed on criticism rather than appreciation.

As the audience for which this paper is written represents the discriminating few, it is well to take into consideration all the points which here influence our judgment in the choice of operation. It will be evident at once that we regard the Whitman operation as the ultimate resource, and that its preponderance over other operations, and the number of conditions for which it is being done, is constantly increasing. At the same time it must be remembered that the circumstances of the patient greatly influence the choice of operation, and that hospital and private practice must always differ. This is also true in contrasting the methods of a large and very busy institution with one treating a smaller number of cases. An operation that may be satisfactory in private may be a failure in hospital practice. We have found, for example, that certain tendon transplantations give beautiful results when they can be assisted by accessories, such as built-up shoes, foot plates, and muscle training; or, in other words, proper postoperative supervision. The identical condition minus post-

operative care will result in failure. Such a statement sounds so brutal in this generation of Social Service and Follow-Up Work, that I cannot let it stand unqualified. Orthopædic postoperative care should end at the grave, and patients intelligent enough to appreciate that fact, and sufficiently persevering, and in adequate circumstances to act upon it are few. At least the intelligence and the circumstances are rarely found in combination, and postoperative care that in general surgery may be taken for granted, in orthopædics practically comes under the head of luxury; as we found in collecting this series of cases, those who lived at a distance simply could not come. They were not necessarily indifferent, as their replies showed, but they could not afford the time and money to visit the hospital. This fact, then, has led us to choose the Whitman operation in a number of cases which elsewhere might be regarded as proper subjects for other procedures.

In spite of the fact that the members of the American Orthopedic Association are probably all thoroughly familiar with the details of the operation, in order to avoid any possible misconception, I think it best to describe briefly its technique.

"The line of incision begins at a point about an inch above the extremity of the external malleolus midway between it and the tendo Achillis, and is continued downward and forward about three quarters of an inch below the malleolus over the dorsum of the foot to the external surface of the head of the astragalus.

The sheaths of the peronei tendons are opened and the tendons are cut below the malleolus and drawn backward. The bands of the external lateral and interosseous ligaments are divided and the head of the astragalus is freed from its attachments to the tibia and the scaphoid. An elevator is then inserted between it and the os calcis, and the foot being forcibly inverted, the head of the astragalus is drawn from the wound, and, the attachments on its inner and posterior borders having been cut or broken, it is removed.

One then prepares the new articulations. A thin section of bone is cut from the adjoining external surfaces of the cuboid and the os calcis and turned back to form a flap. On the inner side a knife is passed about the superior and internal surface of the scaphoid, and the tissues are separated by an elevator. The foot is then displaced inward and the malleoli are laid bare by dissection from their ligamentous attachments and are reshaped somewhat on their internal surfaces to fit the new articulations. The peronei tendons, freed from the lower extremity of the fibula, are passed through a slit at the base of the tendo

Table No 2

		Age of patient	For calcaneus.	For deformity	For stability.	Operator.	Satisfactory	Improved	Poor	Apparatus worn.	Apparatus discarded.	Am't of shortening.	Parent's opinion.	Both Limbs Paralysed.	Secondary to other operations.
1-Jeanette A.		14		--		1	--						s		
2-Ruth E.		13		--		W	--						s	--	
3-Emil G.		11	--			W	--				--	1/4	s		
4-Rose K.		12		--		W	--				--	0	s		
5-Jacob N.		14			--	2	--			--			s	--	
6-Yetta O.		13	--			3	--			--		0	s	--	
7-Anna S.		14		--		3	--				--	1/4	s	--	(a)
8-Irving S.		13	--			3	--				--	0	s	--	
9-Vito R.S.D.	(R)	12	--			3	--						s	--	
10- " "	(L)	12			--	1	--						s	--	
11-Robert B.		10		--		W	--					3/4	s		
12-Rose D.		13	--			4	--					1/4	s	--	(b)
13-Helen F.		10	--			W	--					1/2	s		
14-Ida L.	(L)	9	--			W	--				--		s	--	
15- " "	(R)	"			--	W	--			--			s	--	
16-Annie L.	(L)	16	--			W		(c)		--			s	--	(d)
17- " "	(R)	"			--	W	--			--			s	--	
18-Mary McC.		13			--	W	--						s	--	
19-Martha M.		23			--	W	--				--	1/2	s		--
20-James S.		8			--	5	--				--	1 1/8	s		
21-Arthur B.		9		--		6	s			--		5/8	s		
22-Martin D.		12			--	6		(e)		--		1/2	s		
23-Julius E.		12				W	--				--	3/4	s		
24-Yetta L.		14	--			7	--			--		1/2	s		
25-Eric J.		17		--		W	--					1	s		(f)
26-Minnie S.		8			--	5		(g)				1/2	(h)		
27-Frank M.		9	--			8	--					7/8	s		
28-Molly M.		14		--		9	--						s		
29-John H.	(R)	14			--	7	--			--			s	--	
30- " "	(L)	"			--	6	--			--			s	--	
31-Gladys B.		12			--	10			(i)		--	3/4	(j)	--	
32-Alfred C.		14			--	W	--			--		1/2	s		
33-George C.		14	--			11	--				--	5/8	s		
34-Mary G.		7	--			W	--			--		1/4	s		
35-Catherine C.		13			--	10		(k)		--		3/8	(l)		
36-Clarence J.		8	--			W	--			--		7/8	s		
37-Emanuel K.		11			--	5	--				--	1	s		
38-Hilda P.		12			--	W	--					0	s		
39-Nathan R.		13	--			W		(m)				1/2	(n)		
40-Dora S.		8			--	6	--					1/2	s		(o)
41-Peter B.		4½	--			8	--				--	1/2	s		
42-Frances C.		4½	--			W	--				--		s	--	
43-Florence C.		5	--			5		(p)				5/8	s		
44-Michael C.		7			--	W	--			--		1/2	s	--	
45-Helen E.		5	--			5	--				--	3/8	s		
46-Johanna F		5	--			W	--				--	1/2	s		
47-Eva G.		5	--			W	--				--	5/8	s		
48-Oscar G.		4	--			W	--				--	1/4	s		
49-Richard G.		5			--	8		(q)		--			?	--	
50-Edith H.		9	--			W	--				--	1/2	s		
51-Philip J.		16		--		8	--				--		s	--	
52-Patrick K.		11		--		A.W.	--						s	--	
53-Mary McC.		13		--		W.		(r)					s	--	(t)
54-Matilda M.		21	--			W	--						s	--	
55-Joseph R.		11		--		5	--				--	3/4	s		
56-Murray S.		4½	--			W	--				--	1/4	s		
57-Theodore S.		5			--	W	--				--	1/4	s	--	
58-Mary T.		6	--			2	--					1/4	s		
59-Herbert W.		13			--	6	--				--	1/4	s		
60-Catherine W.		24		--		W	--					1/4	s		

KEY TO DOCTORS INDICATED IN SIXTH COLUMN OF TABLE 2.

1 Strickler.
2 Cilley.
3 Wolcott.
4 O'Neil.
5 Kleinberg.
6 Wallace.
7 Raia.
8 Whitbeck.
9 Zadek.
10 O'Brien.
11 Dupuy.

REFERENCES IN TABLE 2.

(a) Tendon transplantation.
(b) 1912—Ext. Comm. Dig. attached to scaphoid—1914—Davis operation.
(c) Dorsal flexion limited at 80 degrees.
(d) 1. Tendon transplantation. 2. Astragalectomy, resulting in insufficient backward displacement, for which a third operation was done.
(e) Insufficient backward displacement, although dorsal flexion is checked at a right angle—slight valgus.
(f) Tendon transplantation.
(g) Insufficient backward displacement, although dorsal flexion is checked at a right angle—slight varus.
(h) Child easily tired.
(i) Forty-five degrees equinus.
(j) Failure.
(k) Slight equinovarus.
(l) Fair.
(m) Dorsal flexion to 135 degrees.
(n) Improved.
(o) Gallie operation.
(p) Slight varus.
(q) Insufficient backward displacement.
(r) Insufficient backward displacement.
(t) Tendon transplantation.

Achillis, sewn firmly to it, and then drawn forward and reunited to their distal extremities to serve as ligaments.

The foot is now displaced backward, the external malleolus covers the external aspect of the calcaneocuboid articulation, the internal overlaps the navicular. The above mentioned flap is turned upward and sutured to the external malleolus by a mattress suture of chromic gut.

The wound is then closed with catgut sutures and the foot is fixed by a plaster splint in an attitude of moderate plantar flexion and abduction. Except in older subjects and in extreme cases, the peroneal tendons are now neither divided nor transplanted, as the loss of the peroneus longus tends to induce varus deformity if the tibial muscles are active.

In the routine of hospital practice the operation is performed under the Esmarch bandage. The tendons are sutured with kangaroo tendon. The wound, having been cleansed with warm saline solution, is closed without drainage. The foot and limb are bandaged with sterilized sheet wadding, over which a light plaster is applied, holding the foot in the attitude described, and the leg at a right angle to the thigh. The limb is afterwards suspended between tapes running from the head to the foot of the bed. Great care is taken to avoid constriction. To this, and to the rest assured by the plaster splint, and to suspension, is ascribed the very slight discomfort following the operation, and the absence of complications.

At the end of about three weeks the first support is removed, and the walking plaster splint is substituted, extending to the knee, and fixing the foot in the same attitude of moderate equinovalgus, the sole being equalized by the incorporation of a wedge of cork. The patient is encouraged to walk with equal steps, and to bear weight on the forward part of the foot. At the end of from two to four months the new joint will have become stable, and the fixed support may be discarded for a shoe arranged with a cork wedge beneath the heel, of sufficient thickness to compensate for the slight equinus, and if necessary, the outer border of the sole is thickened somewhat to prevent a tendency to inversion.

The patients are directed to report at stated intervals for supervision. As time goes on, the heel may be raised, if necessary, more and more, to compensate for any preëxisting shortening of the limb. As a rule, the thickening of the outer border of the sole may be discarded in a comparatively short time. When it is discarded, however,

Table No. 3

	Age of patient.	For calcaneus.	For deformity.	For stability.	Operator.	Satisfactory.	Improved.	Poor.	Apparatus worn.	Apparatus discarded.	Am't of shortening.	Parent's opinion.	Both limbs paralysed.	Secondary to other operations.
1915-ten cases. (Nos.1-10)	8	4	4	2	W-2 O-8	10			2	5	1/10	5	6	1
1916-ten cases. (Nos.11-20)	8+	4	1	5	W-8 O-2	9	1		3	3	5/8	s-9 l-1	6	3
1917-ten cases. (Nos.21-30)	9+	2	4	4	W-2 O-8	8	2		5	1	19/28	s-9 l-1	3	1
1918-ten cases. (Nos.31-40)	9+	4	0	6	W-5 O-5	7	2	1	2	5	43/80	s-7 l-2 f-1	1	1
1919-twenty cases. (Nos.41-60)	8+	11	5	4	W-11 O-9	17	3		2	12	15/28	s-19 d-1	8	1
Total-60 cases.	8	25	14	21	W-28 O-32	51	8	1	14	26	273/560	s-54 l-5 f-1	24	7

O=others.

parents are instructed in daily manipulations of the foot, and told that they must be continually on their guard against the development of a tendency to varus deformity.

The total of sixty cases examined shows satisfactory results in fifty-one. Eight patients are improved, and one operation was a failure. Fifty-four of the parents, or patients themselves, were satisfied with their condition. From the surgeon's standpoint 85% of the results were satisfactory—from the personal standpoint 90% (see Table No. 3).

The conclusions derived from the investigation are as follows.

1. The operation gives the best results functionally and cosmetically —*i.e.*, the percentage of improvement is greater—in the class of cases for which it was originally designed—talipes calcaneus. It corrects deformity and changes the most crippling variety of talipes into a functionally useful foot. In this field it comes as near being a curative performance as any operation for the relief of paralysis can be.

2. In dangle-foot, with or without varus or valgus deformity, it provides a symmetrical and stable foot, and, unless the paralysis of the extremity is so severe as to require the use of a long brace, enables the patient to dispense with apparatus. It does not correct the degree of drop-foot which may take place at the mediotarsal joint, but as the

TABLE No. 4.

ANALYSIS OF UNSATISFACTORY RESULTS.

1 Florence C. Case 43—Operated June 23, 1919,—left calcaneus, slight tendency to varus. Has had no after-treatment whatever, owing to bad home conditions.

2 Richard G. Case 49—Operated June 23, 1919,—calcaneus, dorsal flexion checked at 80 degrees. Insufficient backward displacement.

3 Mary McC. Case 53—Operated May 19, 1919,—right valgus, secondary operation. Dorsal flexion checked at 80 degrees, still has considerable valgus deformity.

4 Gladys B. Case 31—Dangle foot in equinovarus—operated June 24, 1918. Has a resistant equinus deformity—operation a failure. Has had no post-operative supervision.

5 Catherine C. Case 35—Right varus deformity—operated September 9, 1918. Still has varus deformity, due to slight power in the tibialis anticus and posticus. Should have a supplementary tendon transplantation.

6 Nathan R. Case 39—Right calcaneus—operated January 21, 1918. Has dorsal flexion to 45 degrees in spite of good backward displacement of the foot. Result classed as unsatisfactory, though the patient prefers his present state to that before the operation.

7 Martin D. Case 32—Dangle foot—operated October 29, 1917. Slight valgus and insufficient backward displacement of the foot, though dorsal flexion is checked at a right angle.

8 Minnie S. Case 26—Left dangle foot in equinus, operated March 31, 1917. Very slight tendency to varus, not quite sufficient backward displacement.

9 Annie L. Case 16—Left calcaneo-varus—operated 1916. Dorsal flexion limited at 80 degrees—insufficient backward displacement.

extremity is usually short anyway, requiring of itself the wearing of a high heel, this degree of drop-foot has not in any case been severe enough to require the wearing of apparatus for its correction.

3. For varus or valgus deformity the operation has usually been done as a last resort. The cosmetic results are not as satisfactory as in the former classes, nor is the cure of deformity likely to be permanent unless the operation be supplemented by tendon transplantation or implantation. I feel that it should be recommended in these cases only when other procedures have failed, or when we know that any after-care is out of the question.

From a study of the bad results (see Table No. 4) we have proved two major causes of failure. The first is insufficient backward displacement of the foot, which, with one exception in this series, is accepted as evidence that the original operation was improperly performed.

The second is varus deformity. This may result from:

(a) Faulty operation—failure to place the external malleolus sufficiently far forward.

(b) Persistence of the original deforming factor, be it only a trace of power in either the tibialis anticus or posticus.

(c) The removal of the support afforded by the head of the astragalus to the scaphoid, which occasionally will produce varus deformity in even completely paralyzed extremities.

The first case is too simple to need comment. For Class B we are inclined to recommend transplantation of the deforming agent at the time of or shortly following the original operation. All cases should be treated with the development of this deformity in mind, with a shoe raised on the outside, and with the parents instructed in the daily manipulations of the foot. It is only where these simple precautions have been neglected that deformity in Class C has occurred.

It will be seen, that while the average age of the 1919 cases is no less than that of preceding years, there is a greater proportion six years or under (55%), than in any of the other groups. This fact represents a new departure in treatment, as the youngest operative cases are those of the 1916 epidemic. It may be said that whereas it was the custom formerly to delay operation for almost an indefinite period following the onset of the disease, we now feel that a delay of more than two years is unnecessary. We realize that there is always, under operative treatment, massage, muscle training, or electricity, the possibility of a certain regeneration of muscles that at a primary examination might have appeared to be totally paralyzed. The return of power to the flexors of the toes following astragalectomy, for example, has become a familiar phenomenon in this hospital. Except in cases which have been absolutely neglected and been suffered to run wild, with resultant deformity or manifest constant over-fatigue, there is not likely, after two years, to be a return of power to a muscle sufficient to be of practical value from a locomotive point of view.

Upon this premise, then, we are now, April, 1920, starting the operative treatment of the 1916 cases, upon the theory that a proper operative result will permit the discarding of apparatus and result in the greater functional efficiency of the limb. It is our hope and belief, that the earlier the functional use, the less will be the eventual atrophy of the entire extremity. Particularly do we hope to check the extreme atrophy and distortion incident to talipes calcaneus.

One of the most striking facts brought out by the investigation is in relation to the patient's brace-wearing. The operation enabled the discarding of all apparatus upon the affected limb in twenty-six cases. Only fourteen out of sixty wear apparatus at all, and in all of these it is worn because of paralysis above the knee.

The removal of the astragalus causes an average shortening of half an inch, for which it is our custom to compensate by the wearing of an inner heel. None of the patients mentioned this shortening as a cause of dissatisfaction. This is of interest chiefly because a writer of some prominence has characterized the operation as "mutilating."

A study of statistics will doubtless be of more value than my personal opinion. As the study of statistics is sometimes deferred until a time never attained, I may, perhaps, be excused for ending this paper with a simple statement:

Sixty cases were examined, of which twenty-eight were operated on by Dr. Whitman and thirty-two by other surgeons on his service. Eighty-five per cent. of the results were successful. Sixty five per cent. of the patients wearing apparatus were enabled to discard it. One patient regarded the operation as a failure. Ninety per cent. were satisfied with their condition.

Those who are really interested in the subject can gain satisfactory information from a study of the case records. They will there find that all but three of the bad results may be—and indeed several have already been—corrected by measures varying from simple manual stretching to secondary operation for further backward displacement of the foot upon the leg. They will observe that most of these procedures might have been obviated by elementary postoperative care.

The fact in the study of these patients that is to me most striking is that in spite of the variety of disabilities to which the application of this operation has been expanded, and in spite of the hard conditions of this particular hospital practice, its results are so satisfactory to the patients themselves. That its results are also good from the standpoint of technical criticism is only further testimony to the theoretical soundness of its conception.

LENGTHENING OF THE QUADRICEPS TENDON.

BY GEORGE E. BENNETT, M.D.

Associate in Clinical Orthopaedic Surgery Johns Hopkins Medical School, Assistant Visiting Orthopaedic Surgeon Johns Hopkins Hospital

In the September, 1919, issue of the *Journal of Orthopaedic Surgery* we published a paper entitled "Preliminary Report of Lengthening of the Quadriceps Tendon." In this article we called attention to the part the quadriceps tendon played in the loss of mobility of the knee joint, following lesions of the femur, such as fractures, simple and compound, osteomyelitis of the femur, fractures of the tibia and fibula, and ununited fractures of bones above and below the knee joint, requiring long immobilization.

It is a well-known fact that in a small percentage of cases such as have been enumerated, one sees a permanent loss of complete or partial flexion of the knee joint, notwithstanding the fact that the lesion has been entirely an extra-articular affair.

Attention was also called particularly to the part the quadriceps plays; contractures, adhesions, and other conditions to which muscles may be subjected, and three cases were reported in which we had succeeded in increasing the range of motion by lengthening the tendon, and the methods of procedure were described. Since that time the number of cases has increased to eight, seven of which have unquestionably had very satisfactory results, while the eighth case only showed no improvement.

Even at the expense of being accused of reiteration, we think it would be well to touch lightly on the anatomy of the anterior thigh, since in a description of the operation itself, it is very necessary that this point should be perfectly understood. The relationship between the crureus and vastus internus and externus muscles is very close in the lower third of the femur, and their tendons are inseparable. The crureus, lying deepest of the three and on the anterior surface of the shaft of the femur, is easily tied down by adhesions, thereby rendering absolutely inert the function of the other three muscles forming the quadriceps. We feel perfectly free in making this rather startling assertion, as we have seen a case where the rectus, by adhesions high

up in the thigh, had produced a complete loss of motion of the knee joint. If this can be true of the most independent section of the quadriceps group, why should it not be true of the less independent members, that is, the vastus internus and externus and crureus?

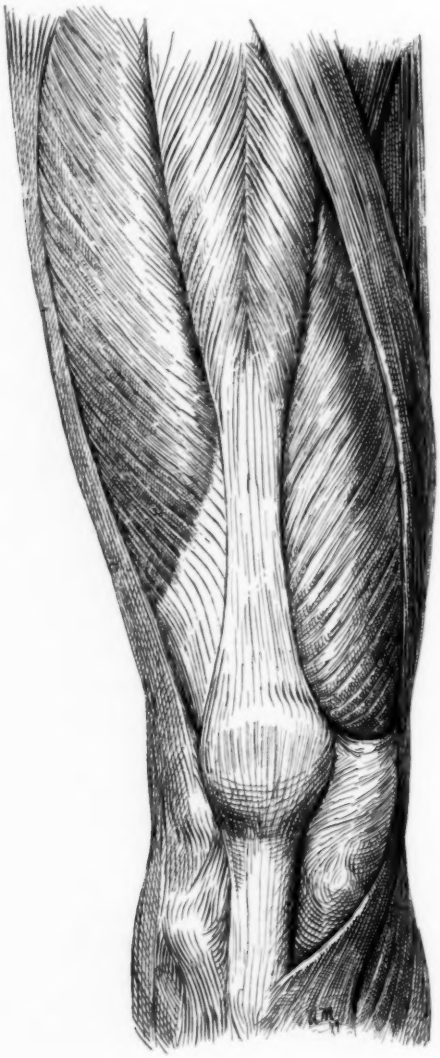


FIG. A.

In our former article no note was made of changes in the capsule of the knee joint, because we were very much surprised to find, in the first two cases on which we operated, very little, if any, evidence of contraction, hardly as much as one would anticipate from lesions

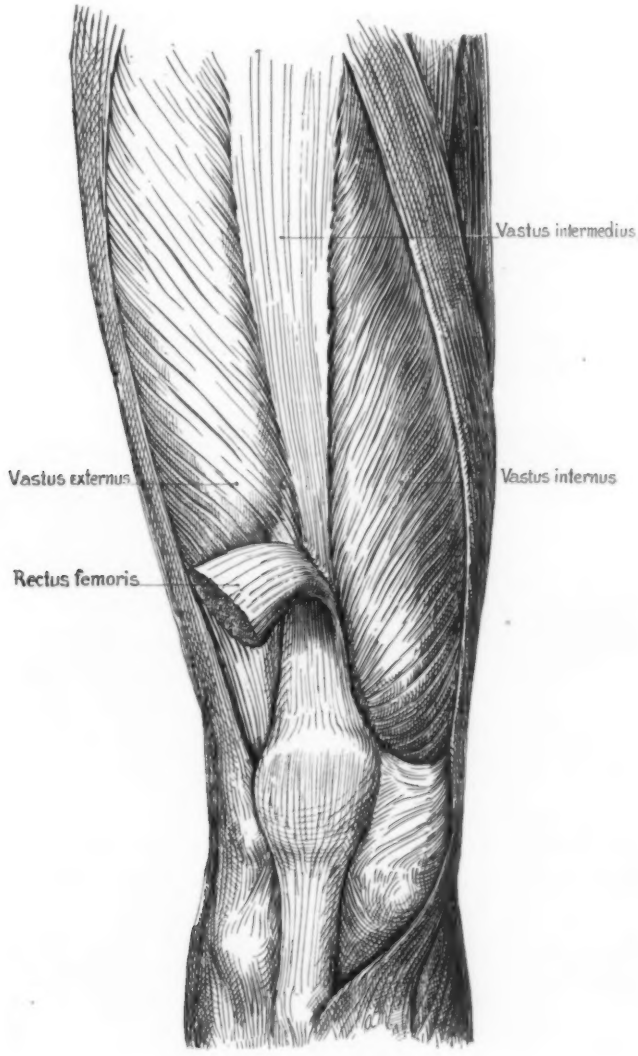
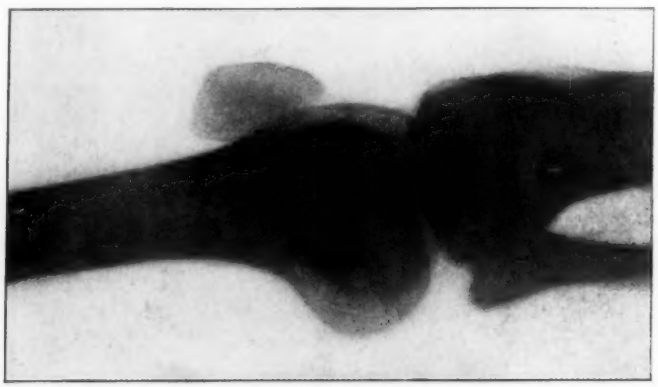


FIG. B.

which had existed over a period of from six months to seventeen years. Our third case did demonstrate, in a mild degree, certain changes in the capsule, but not as marked as one had been led to believe in older instructions.

We believe that the changes within the knee joint itself are comparable with the changes which one would expect to find in the ankle joint, if the tendo Achillis was lengthened to correct an equinus deformity that had persisted for a long time. In other words, we recognize capsular changes. There is a certain amount of obliteration of the quadriceps pouch, but we wish to emphasize that the chief offender in the production of this condition is the contraction of the quadriceps tendon and adhesions. The capsule is entirely a secondary affair, and will take care of itself, — will, in fact, be totally relieved, when the tendon contraction has been overcome.

We believe that this problem can be more clearly understood by following a rather detailed recital of the histories of the cases which have been operated on; a study of the problems which presented themselves with each case, of the changes noted, and of the end result.



X-ray of knee before operation. Case 1.

Case No. 1. N. C. Age 34. (Previously reported in *Journal of Orthopaedic Surgery*, September, 1919.) Admitted to Johns Hopkins Hospital June 19, 1917.

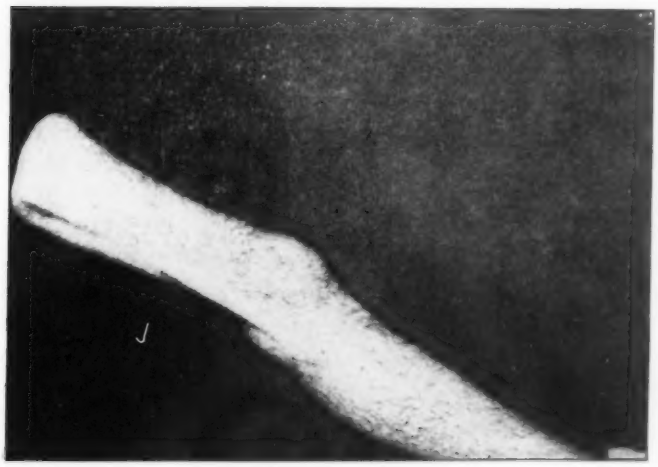
Diagnosis: Old healed osteomyelitis of upper third of femur. Old healed osteomyelitis of the clavicle. Contraction of the quadriceps tendon.

Complaint: Stiff knee.

Family History: Unimportant.

Past History: Unimportant.

X-ray. Osteomyelitis upper third femur, which tied down the fibres of the rectus. Case 1.



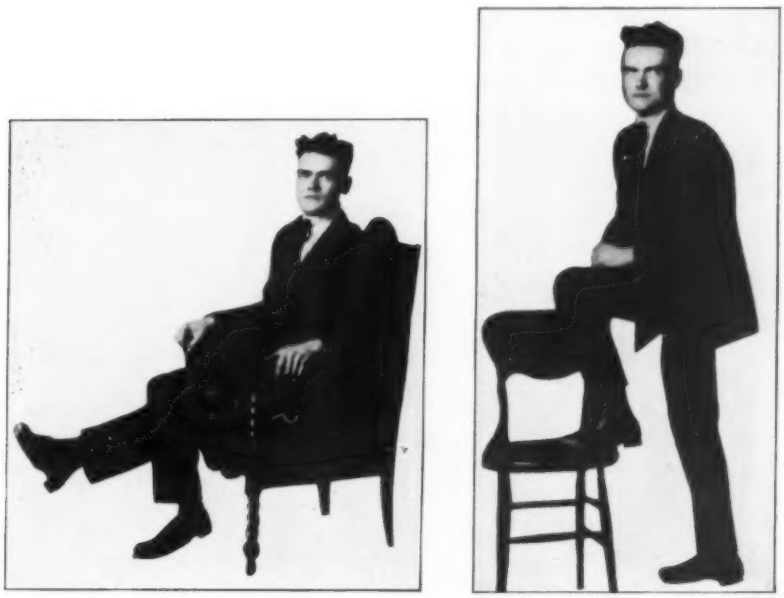
Photograph before operation. Case 1.

Present Illness: Onset after injury to spine at the age of six or seven. Following this injury, the patient was unable to sleep at night for about one month. Right leg became swollen, and there was marked pain. Patient was confined to bed six or seven weeks. After this he walked with crutches. In the meantime abscesses had formed and broken down. Relief from pain after the evacuation of the abscesses was marked. Abscesses continuing to form at the rate of about two each year for several years. At the age of ten, an abscess appeared on the left clavicle; this was treated surgically, as well as one on the right arm. Several pieces of bone came from the thigh abscesses at different times. At the age of fifteen, the right knee became stiff, and has remained so ever since. Reaching the age of twenty-one, the patient has had no more abscesses. He comes to the hospital to see if motion can be obtained in the knee.

Previous Operation: January 17, 1914, was admitted to Johns Hopkins Hospital. Exploration of upper thigh and attempt to relieve contracture and adhesions was without result. Re-admitted to Johns Hopkins Hospital on June 19, 1917, for operation reported in this article.

Physical Examination: (Reported from Johns Hopkins Hospital History.) There is rather marked atrophy of the muscles of the right thigh. Calves appear the same size. There is a long scar just below the greater trochanter on the right thigh, which is adherent to the bone. Normal motion in right hip. Flexion of knee is limited to fifteen degrees, with marked contraction of the quadriceps tendon when knee is forcibly flexed. Lateral motion of knee seems fairly free. Scar of former operation over left clavicle. Atrophy of right thigh is thirteen cms. Atrophy of right calf is one-half cm.

Operative Note: (Report from Johns Hopkins Hospital History.) Operation June 25, 1917. Manipulation of right knee. Lengthening of quadriceps femoris tendon, right. Iodine technique. After patient was fully anesthetized, the right leg was brought over the end of the stretcher, and with the pelvis firmly held to the table the leg was flexed on the thigh for several minutes in an effort to break up joint adhesions. Approximately five degrees of flexion were gained in the manœuvre. It was noticed that, although the knee could not be flexed more than twenty degrees, lateral motion in the knee joint appeared quite free, and that the patellar and quadriceps tendons were apparently contracted and limiting joint motion. The thigh was then cleaned up with iodine and alcohol and a long incision was made over the quadriceps tendon. The knee was allowed to flex over a pillow. The tendon of the rectus



Case 1. N. C. End result.

femoris was tightly contracted. This was divided and the fibres of the vastus internus and externus dissected loose. The leg could now be flexed ninety degrees, and motion was quite free. The vastus externus and internus tendons were sutured to the distal end of the cut rectus femoris tendon with several sutures of heavy braided white silk. Subcutaneous tissue was closed with interrupted sutures of plain catgut and the skin with continuous fine black silk suture. Sterile dressing.

DISCUSSION

Patient made an uneventful recovery from operation, and at the end of four weeks was walking about with eighty-five degrees of motion. This has continued until, at the time of writing, he has approximately one hundred and twenty degrees of free, painless motion, with a quadriceps tendon in full power. This enables him to perform his occupation as carpenter. He states that he is able to carry one hundred and fifty pounds on his shoulder, going up stairs foot over foot without any discomfort.

The points of particular interest in this case are the duration of the loss of motion in the knee over a period of seventeen years before

operation, no contraction of the capsule noted at the time of operation, and that the structures of the knee joint were in very good condition prior to operation. The rectus tendon was the element at fault, with adhesions in the upper thigh, and contraction of the quadriceps tendon.

X-ray before operation. Case 2.

Case No. 2. Mrs. M. B. (Previously reported in *Journal of Orthopaedic Surgery*, September, 1919.)

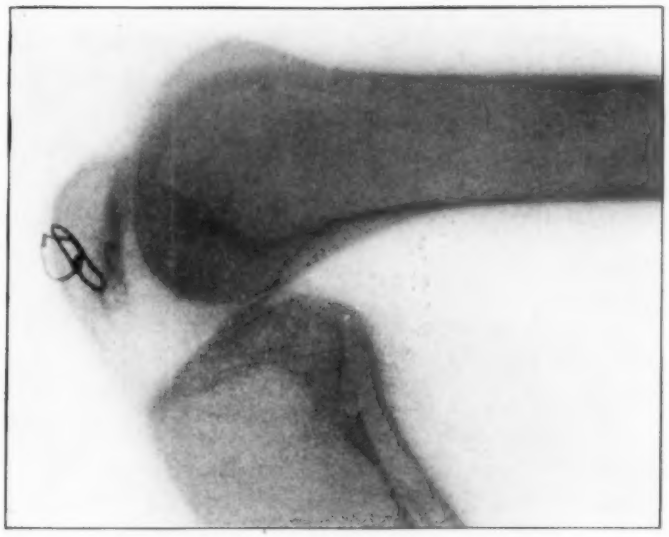
Comminuted fracture of right patella. August 17, 1917—Open operation and wiring. Immobilization in extension. Massage begun October 20, 1917.

Manipulated under anesthesia and continued treatment until operation February 4, 1918, at which time patient had thirty-five degrees of motion, as shown in X-ray taken with leg held in forced flexion.

DISCUSSION

This patient had ideal treatment following removal of plaster splint, constant massage and apparatus work, but in spite of this only thirty-five degrees of motion were obtained at the end of four months.

A full normal range of motion came four months after operation. Approximately one year after operation motion in the knee became painful



X-ray ten weeks after operation. Case 2.

from a thickening of synovia, caused by a large patella. A reduction of the size of the patella relieved all discomfort. Patient is able to ride horseback and lead an athletic, active life.

No capsular contraction was noted at time of operation. It is our opinion that this was an example of contraction of the quadriceps group.

Case No. 3. G. J. G. Age 23. White male. (Previously reported in *Journal of Orthopaedic Surgery*, September, 1919.) Admitted to Johns Hopkins Hospital March 13, 1919. Discharged April 29, 1919.

Case No. 4. G. J. G. Age 23. White male. Admitted to Johns Hopkins Hospital June 29, 1919. Discharged August 23, 1919.

Family History: Unimportant.

Past History: Unimportant.

Present illness: In an automobile accident June 25, 1915, patient sustained a compound fracture of the right femur, eight inches above the knee, and a simple fracture of the left femur, six inches above the knee. Both limbs were put up in traction and the wound on the right thigh irrigated daily. At the end of three weeks an open reduction of the fracture on the left was done, the fragments being plated and the limb being put up in a long plaster hip spica. The wound on the right closed at the end of nine weeks, at which time a plating operation was

Photograph four months after operation. Case 2.

done on this side, and a long spica applied. The cast on the left side was cut an inch or so shorter at various times, so that it was not until October of that year that the knee joint was exposed. By the end of December, 1915, the right knee was also free for motion; massage and later manipulation were instituted. However, the legs remained stiff at the knees. In August, 1918, several manipulations under anesthesia were unsuccessful. On September 12th, the bone plate of the right was removed without improvement. Stiff knee condition remains as on admission.

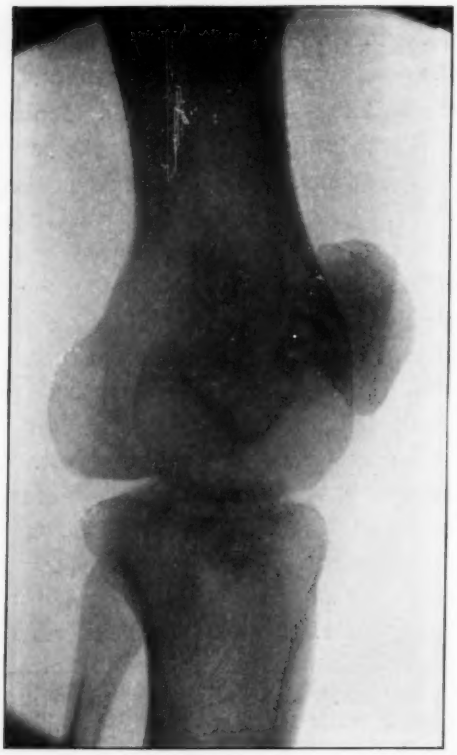
Physical Examination: Right leg: The patient walks with both knees stiff. There is a large scar over the middle of the lower end of the femur extending over the external condyle to the patellar tendon, evidence of operation for relief of adhesions and plating operation for compound fracture.

Left leg: Scar on the outer border of the lower third of femur, result of operation for fracture. Some thickening of the femur. Patella freely

movable. Fifteen degrees of flexion can be obtained, when a sudden shock is felt and the quadriceps tendon becomes taut.

Operative Note: Left leg—March 13, 1919. Iodine technique. Incision was about nine inches long, beginning at the patella and extending upward parallel to the femur. The subcutaneous tissues were divided and dissected laterally. These were then retracted, exposing the quadriceps tendon. There was found to be considerable scar tissue about the quadriceps tendon, and it was firmly adherent to the femur about four inches above the patella. These longitudinal incisions were then carried laterally, so as to divide the tendinous portion of the vasti muscles. This left about four inches of the quadriceps tendon, three-quarters of an inch wide, attached to the patella. The tendons of the vasti muscles were then dissected free where they were tied down, and with considerable force the leg was flexed almost at right angles. Dissection was made with considerable difficulty, as all the tissues were tied down very firmly to the femur. The capsule was also quite adherent to the tendon, so that in making the dissection the capsule was punctured in one place near the upper portion of the patella. With the leg flexed almost at right angles, the central portion of the tendon which was still attached to the patella was sutured to the vasti muscles in a lengthened position, leaving a space of nearly three inches above the central portion open. The vasti were then sutured across the open space, and sutured also firmly to the central portion of the quadriceps tendon. This gave a lengthening of the quadriceps tendon of about three inches. Chromic catgut and braided silk were used in this suturing of the tendon. The deep tissues were sutured over the quadriceps tendon with chromic catgut. The superficial tissues were closed with plain catgut. The skin was closed with silk. Plaster cast was applied from toes to groin with knee flexed at eighty degrees. Patient left the table in good condition.

Post-operative Note: The post-operative course on the whole was uneventful. Some ecchymosis appeared about the thigh. The temperature went up to as high as 101 on several occasions the first week. After that, however, the condition was excellent. On the 27th day of March the cast was removed. The wound was found healed *per primam*. The knee could be flexed to 100 degrees without any discomfort. Following this, a mild course of massage, with later manipulation, was begun. At the time of discharge, the patient was able to actively extend his knee to within fifteen degrees of normal. Limb could be flexed to eighty degrees. There was practically no local discomfort.

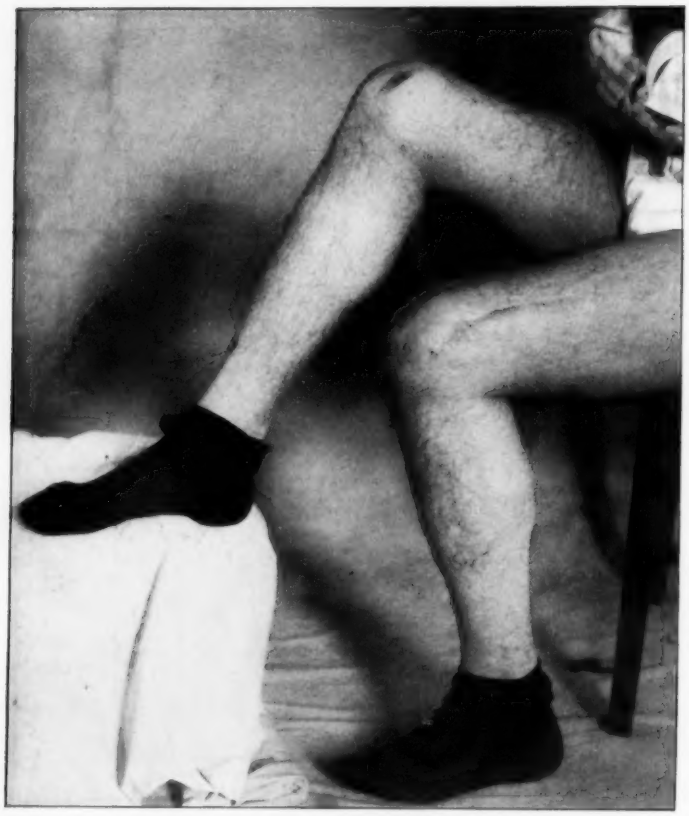


Cases 3 and 4. G. J. G. Right leg in forced flexion before operation, showing degree of motion.

Operative Note: Right leg—June 30, 1919. Case No. 4. Iodine technique to the skin. An incision was made on the anterior aspect of the thigh from about the middle of the thigh running down longitudinally to a point just over the lower margin of the patella. It was carried through the skin and the subcutaneous tissues to expose the quadriceps tendon. There was a lateral dissection of the skin, permitting an exposure of the entire width of the rectus femoris muscle, together with the insertion of the vasti into its lateral border. Owing to the numerous adhesions between the various tissues, the dissection proved to be more difficult, and there was more bleeding than usual. With the muscles exposed, efforts at flexion showed that most of the restriction of flexion was due to the binding down of the tendon by the lower fibres of the vastus internus muscle. In freeing the quadriceps tendon from these restricting bands, an incision was made from the middle of the lateral margin of the patella to the junction of the rectus tendon to the body of the muscle. A similar incision was made on the inner aspect of the

Cases 3 and 4. G. J. G. Left leg in forced flexion before operation, showing degree of motion.

rectus femoris, the upper end of the incisions being connected by a curved incision line. This left the patella with its upper portion attached to a tongue of tendinous tissue, free from the vasti on either side, and from the belly of the rectus muscle above. This flap was then dissected up from the underlying tissues, care being taken not to enter the joint cavity. Flexion then proved to be restricted by intra-capsular adhesions. With a little forceful manipulation, however, these adhesions could be broken, and 120 degrees of flexion of the knee obtained. The problem of resuturing the tendon into its lower position was then begun. With the leg flexed at 80 degrees at the knee, the tendon was sewed rather tautly to the vastus internus. In order to further facilitate the slipping of the tendon, a pad of fat about three inches in diameter was dissected out from the subcutaneous layers of the outside of the thigh, and placed underneath the rectus tendon. The outer side of this was then pulled up



Cases 3 and 4. G. J. G. End result.

as high as could be, with the knee in the flexed position, and then sewed firmly to the tissues of the externus vastus which had previously been dissected up. The upper portion of the tendon was pulled as far as could be managed to the belly of the rectus muscle. The cavity left was closed over by the joining together of the lateral margins of the space. All the suturing was done with chromic catgut, and the skin, by means of a locking silk continuous suture. It was found, however, on effort to close the skin, that the contracture of the skin had been so great that the incision edges would not unite in the newly flexed position without extreme tension being made on the skin. To relieve some of this tension, two longitudinal incisions were made about an inch to either side of the

Cases 3 and 4. G. J. G. End result.

incision line. The improvement in the circulation of the tissues was quite noticeable when these incisions were made. These relaxation incisions were just through the skin. Dry dressings were applied and a plaster cast put on with the knee flexed 80 degrees. Patient stood the operation well.

Post-operative Note: July 1, 1919. Patient feels fairly comfortable. Temperature 100.2. Cast in good shape. Circulation in toes good.

July 2, 1919. Because of rise of temperature to 101.2, a white count was done. This showed 11,000 leukocytes. Patient feels fairly well. Appetite has not yet returned. Circulation in toes good.

July 5, 1919. A window was cut in the cast at the knee. There were several blood clots at the side of the two lateral incisions. Slight oozing of these wounds took place. Incisions were washed with alcohol and dressed with gauze. Patient's temperature fell to 99.8 after the dressing,

but at 7 p. m. was up to 100.4. Patient feels well. The tissues about the knee are black and blue.

July 7, 1919. Hot boric compresses applied to knee. Patient feels well. Highest temperature 99.8. The area of discoloration is more evident on the lateral aspect of the knee.

July 10, 1919. Skin in very good condition, ecchymosis cleared up. Stitches removed. Temperature normal.

July 20, 1919. Anterior half of cast removed: posterior half padded and bandaged to the leg.

July 22, 1919. Leg extended until it lacked thirty degrees of full extension.

July 25, 1919. Patient getting around on crutches. Feels that right leg is weaker possibly than the left leg at the corresponding time after operation.

July 29, 1919. Massage commenced.

July 31, 1919. Patient awoke to find a small amount of dark blood had escaped from one of the stitches which has apparently healed. Several c.c. of old blood was squeezed out. Iodoform drain inserted. Pocket is at least 2.5 cms. deep.

August 2, 1919. Considerable amount of old blood and necrotic material was expressed today. Massage discontinued.

August 7, 1919. Sinus completely healed. Patient took a few steps unaided in any way.

August 16, 1919. Walks gradually.

August 23, 1919. Patient has only 25 degrees of active extension on the right leg, 10 degrees less than full passive extension. 70 degrees of flexion, no pain. Patient is improving under massage and manipulation. To continue with this. May be discharged.

DISCUSSION.

Special points of interest in this patient: On the left leg, which was rather the better of the two, there was a great deal of difficulty in bringing the knee down to a flexed position, and this difficulty was due to contractures of the capsule. However, there was a quick return to function, and the patient reports at this time a very good, satisfactory leg, with 110 degrees of motion.

The right leg—operation June 30th. Here, the scars and adhesions between the thigh and quadriceps group were so great that it was only with extreme difficulty that we were able to detach them from the bone. The tendons had to be freed at the lateral borders of the vasti and brought anterior. A large piece of fat was placed under the newly

sutured tendon, and a great deal of resistance was met with in the capsule. Adhesions about the anterior thigh were so great, and the tension of the skin so marked, as to interfere with circulation. It was necessary to make linear incisions either side of the patella to relieve the tension when the knee was flexed at an angle of eighty degrees. The postoperative notes will show the marked ecchymosis which occurred with a slight rise of temperature. The patient went on to an uneventful recovery, with rather a slower return to power than in the former operation. A few months after the operation he was able to walk up and down stairs, foot over foot, as a normal individual. He now swims and leads an athletic life, having well over 100 degrees of motion in both legs.

This was, in my opinion, a severe test case for this operation, for this case presented contraction of the muscles from long immobilization, dense adhesions from primary plating operation and suppuration, and from operation for the removal of plate and freeing of adhesions. The incision of the latter extended from the middle third of the thigh over the external condyle and across the patellar tendon.

This may seem a great deal of detail in history, but a careful perusal of such detail will answer questions that have been asked on many occasions.

Case No. 5. Age 24. White male. S. M. Admitted to Johns Hopkins Hospital October 15, 1919. Discharged November 30, 1919.

Complaint: Stiff knee.

Family History: Unimportant.

Past History: Unimportant.

Present Illness: On June 25th, 1915, patient fractured the left thigh in an automobile accident. The fracture was about six inches above the level of the knee. Patient did not know whether it was compound or not. Was taken to a hospital shortly after accident, traction was applied for three weeks, and then an open reduction was done, in which both fragments were plated. Limb was put up in full extension at the knee in a plaster cast. Six months after this all immobilizing agencies were removed and massage and manipulation were begun. At first manipulation was mild in character, but later more violent. Knee did not yield to treatment. About the middle of October of 1916, an operation was again performed in which the bone plates were removed in the hope that the adhesions which had formed around them would be sufficiently relieved to permit flexion at the knee. This operation, however, was of no avail. With the exception of mild manipulation by the patient himself, nothing was done after this until January 25th, 1918. At this time an operation was performed by Major —— at the Walter Reed Hospital at Washing-

Case 5. S. M. Movement in knee before operation.

ton, D. C., the operation consisting of an attempt to relieve the adhesions which had formed about the fracture and the removal of some of the extensive callus which had formed about the point of union. After this operation, the patient was again put in plaster for about one month. After this, manipulation was again attempted, with the result that about five or ten degrees of motion were obtained. Subsequent to this, patient went about with his knee practically stiff. No further attempts at correction were made. It is noteworthy that following the operation of January, 1918, the thigh wound became infected, with subsequent irrigations with Dakin's solution over a period of several days. Patient comes in for operative correction of the deformity.

Physical Examination: All extremities, bones and joints, are negative, except for the left leg, upon which all interest centers. The left leg shows an apparent shortening, with some slight atrophy and a scar above the knee on the outer side. At full extension the knee looks almost normal, although there is not the usual hollow above the knee in front. The patella is freely movable. All muscles seem to be in good tone, both thigh and calf. On motion, flexion at the knee is possible only 20 degrees, when

the tendon tension prevents further extension. There does not seem to be any bony ankylosis or any bone change in the joint. Above the knee at the scar level and at the seat of the old fracture there is a bony increase in width, almost twice normal. The quadriceps tendon is tied to the scar in one small area. No pain on motion. Flexion beyond 20 degrees is impossible even with force.

Operative Note: October 23, 1919. Lengthening of quadriceps tendon on left side for partial ankylosis of the knee joint. Iodine skin technique, patient in supine position on table permitting flexion of the knee joint.

A longitudinal incision was made over the middle of the anterior aspect of the left thigh, reaching from above the middle to about the middle of the patella. Skin was dissected up from either side with the subcutaneous fascia so as to expose the quadriceps tendon below. The rectus femoris and the internal and external vastus muscles were laid clear, together with the insertion into the upper end of the patella. Flexion of the knee joint then showed clearly that the restricting bands were in the region of the vastus externus. An incision, therefore, was made from the outer border of the patella upward along the line of insertion of the vastus externus into the rectus, so as to separate the patella from the restricting fibres. Mild efforts at manipulation of the knee joint then

Case 5. S. M. Movement in knee before operation.

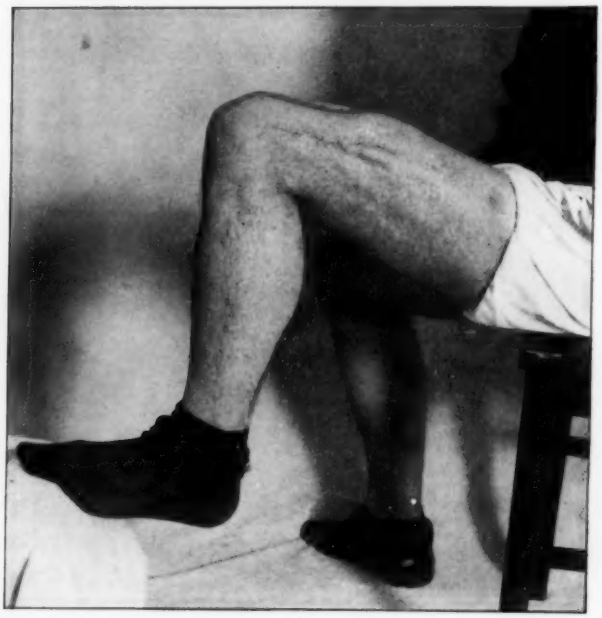
showed considerable resistance to flexion on account of contracture of the rectus femoris and vastus internus, though some relaxation was obtained. The incision, therefore, was made on the inner aspect of the patella, running upward along the course of the insertion of the internus to the rectus, incision running up the attachment of the tendon to the muscular portion of the muscle. A transverse incision then connected the blind ends of the lateral and median incision lines. The distal portion of the rectus femoris was dissected up from the bone beneath it and reflected back. Flexion was then made and the knee brought through an angle of somewhat more than a right angle. The first efforts at flexion after the muscle had been cut loose were met with considerable resistance,

Case 5. S. M. Forced flexion before operation.

apparently due to internal capsular adhesions. These were broken as the knee was bent, and the upper portion of the capsule, which was tacked down to the femur, seemed definitely to pull loose from the bone beneath it. Apparently, therefore, the entire limitation of motion could not be blamed upon the muscular tissue, although the muscular tissues had brought about the greater element.

The knee was then put up in flexion of 90 degrees, the quadriceps tendon was sewed as high up as possible with this angle to the vastus internus by means of kangaroo tendon. The tendon was then allowed to resume the place it had held naturally, and the lateral border of it sewed to the vastus externus, likewise with kangaroo tendon. A gap of about

Case 5. S. M. Extension before operation.



Case 5. S. M. End result.

one inch was left between the upper end of the tendon and the lower end of the rectus muscle from which it had been severed. Efforts were made to occlude this gap by drawing down the muscle tissues of the rectus and by pulling together the vastus externus and internus. The subcutaneous tissues were then closed with plain catgut sutures and the skin closed with sutures of fine silk. A plaster cast was then applied from groin to toes with the knee in 90 degrees of flexion. Patient lost but little blood and stood the operation very well.

DISCUSSION.

The point of particular interest in this case is the duration from the time of original injury, June 25th, 1915, to time of operation, October 23rd, 1919. Patient had a few degrees of painless motion. Leg had been functioning for approximately three years. Some capsular resistance was met with, but not as marked as in cases three and four. Patient developed a post-operative infection, probably due to the lighting of a latent infection from former operation. The quadriceps tendon behaved very much as one would expect of a mildly infected tendon. Patient went on to an uneventful recovery, and at the time of leaving our care had well over 90 degrees of motion, and was able to walk up and down stairs four months after operation. Since that time, motion has increased to extent shown in illustration.

CASE No. 6. H. W. G. Age 38. White male. Admitted to Johns Hopkins Hospital October 14th, 1919. Discharged December 9th, 1919.

Family History: Unimportant.

Previous History: Unimportant.

Present Illness: In an automobile accident April 26th, 1917, sustained a compound fracture of the right and left leg below the knee (lower third of the tibia and fibula). June 9th, 1917, had operation to clear up infection and adjust fractures. Several small detached pieces of bone removed. Following this the leg improved, but had second operation January 1, 1918, for removal of sequestrum on right leg. This leg has had ulcerations on several occasions since. Was able to be up and began to walk with knees stiff about August, 1918, assisted with crutches. Since this has had massage, etc.

Physical Examination: Patient has a marked bowing outward of both legs. This is particularly pronounced on the left side. The bowing is found chiefly below the knee. On the left side, the joint permits of about fifteen degrees of flexion, has full extension, but no hyperextension. No abnormal lateral mobility. The extremes of the arc of motion do not

seem to be caused by any bone limitation. Palpation of the knee joint produces no pain, nor is there any thickening of the synovial membrane. The patella slides freely over the joint surface. There is no increase in joint fluid. The bones of the leg are apparently firmly united in the position of varus deformity, the skin over the point of fracture being well healed.

On the right side there is a similar picture with the following exceptions: 45 degrees of flexion is permitted and the bowing is less marked. Over the middle of the tibia there is a small sinus from which a drop or two of pus exudes. X-ray examinations of both knees are negative.

Impression: Contracture of the peri-articular structures of the knees, as a result of abnormally long fixation of the knee joints in full extension.

Operative Note: October 15, 1919. Lengthening of the quadriceps tendon for contraction with immobilization of the knee joint, left.

Iodine skin technique. A longitudinal incision was made on the anterior aspect of the left thigh from about its middle to the middle of the

Case 6. H. W. G. Flexion before operation.

patella below. The incision was deepened to expose the rectus femoris muscle. Later dissection then facilitated an examination of the vastus internus and externus. The knee was flexed to its maximum, and the effect of this flexion was noted on the various branches of the quadriceps muscle. Apparently the chief restricting factor was the rectus femoris. An incision was then made transverse to the rectus femoris tendon, just at its point of insertion into the patella, cutting the tendon in its entire width. Longitudinal incisions were then made from either end of this transverse section along the course of the rectus tendon at the point of insertion of the vasti into this tendon. The incision was carried up on the thigh for a distance of about four inches. Forcible flexion then permitted an angle of 90 degrees to be obtained. The flexion was rather difficult to obtain, apparently due to adhesions in the knee joint and contraction of the inner band of the vastus externus. To relieve some of the

Case 6. H. W. G. Extension before operation.

tension when the knee was flexed at right angles, the fibres of this restricting band of the vastus externus muscle were cut transversely at the proximal portion of the incision made previously. With the knee flexed at a right angle, there was a gap left between the insertion of the patellar tendon and the distal cut portion of about two inches. To cover this gap the border of the vastus internus and externus, which had been cut, were sewed together so as to practically obliterate the space left by the retraction of the femoris. The rectus femoris in its new position was sewed to either side of the muscle tissue, the entire incision line being joined to the adjoining muscle with kangaroo tendon. The fascia was then sewed over this by means of chromic catgut, the subcutaneous plain catgut suture line was inserted, and a long continuous lockstitch silk suture completed the closure of the skin.

Post-operative Note: Plaster was removed at the end of three weeks. Patient had an uneventful post-operative recovery. Massage was insti-

Case 6. H. W. G. Forced flexion before operation.

tuted in the fourth week. Patient was discharged on December 9th with 60 degrees of painless motion, which has increased to 90 degrees since.

DISCUSSION.

This case shows a true contraction of the muscles of the anterior thigh, due to long immobilization in full extension for a lesion below the knee.

CASE No. 7. A. L. Age 21. White male. Operated on at Ruptured & Crippled Hospital, New York, December 30, 1919.

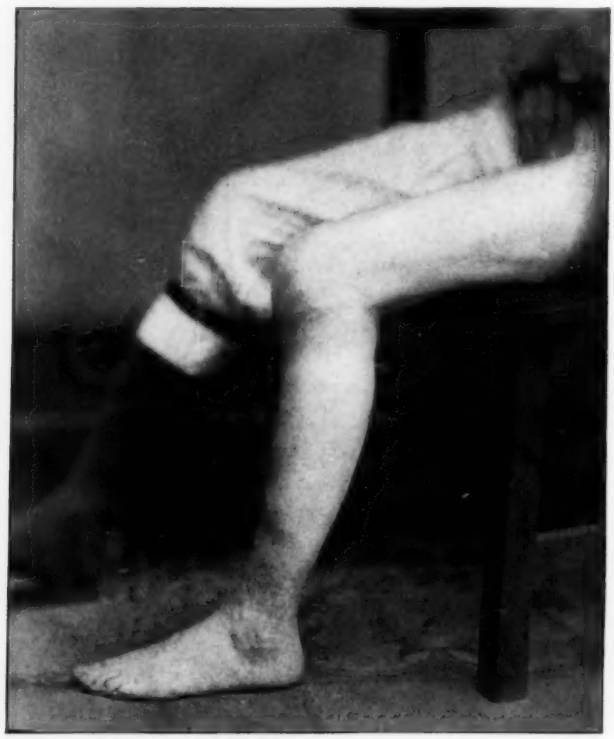
Family History: Unimportant.

Past History: Pneumonia when two years old. Diphtheria when eight years old. Following diphtheria, patient developed pain in right thigh, which continued for ten weeks, when it subsided, not to return until a lapse of one year. Then a growth developed on the inner aspect of the thigh at its highest point. This growth was about the size of an orange.

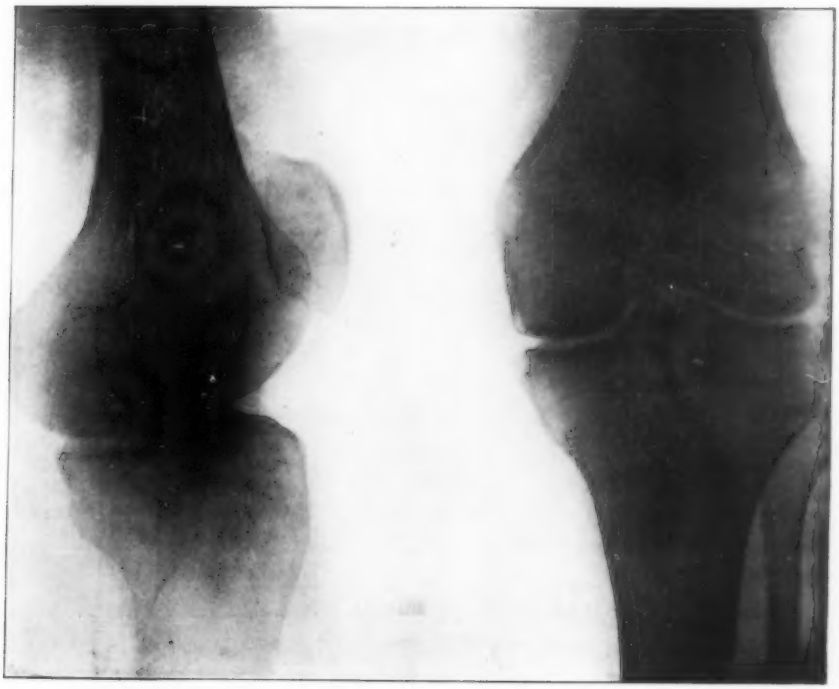
Case 6. H. W. G. Extension before operation.

After a year this tumor ruptured and drained for a whole year. In 1911 patient was operated on and about forty-five pieces of splintered bone were removed. Six weeks later was discharged from the hospital. Two weeks after discharge from hospital developed pleuro-pneumonia, which proved severe. Was sick for six weeks. In 1912, a year after operation, there was a discharge at the site of tumor. Since then there has been no return of symptoms in thigh.

Present Illness: On October 26th, 1918, without apparent cause, patient had pain in right knee and leg was fixed in flexion. Was treated first as rheumatism. Later condition was diagnosed as septic arthritis, and treated by application of plaster cast and extension for three months. This treatment failed to give the desired results and pain and stiffness remained. Nothing has been done since, but patient is better able to



Case 6. H. W. G. Flexion after operation.



Case 7. A. L. X-ray taken before operation.

get around, having to avoid sudden jars or becoming fatigued. Is now admitted for forcible correction under anesthesia.

Physical Examination: Patient admitted without apparatus, walking with a stiff knee on the right side.

R. A., 38¼. R. T., 16½. R. K., 13¼, 13⅝, 12¾. L. A., 38¼. L. T., 20½. L. K., 14, 14, 12⅞. R. C., 12½. L. C., 12¾.

Moderate infiltration about the right knee joint, most marked in the suberural pouch about the patella. The patella is slightly movable.

A. G. F., 165.

A. G. F., 160.

With this amount of motion there is no pain or muscle spasm. The limitation seems to be a mechanical block. The x-ray picture shows thinning of the cartilage and general rarefaction of the bones. Slight thickening, more marked on the inner side of the head of the tibia and condyles of the femur. No erosion of the joint surfaces.

Operative Note: November 10, 1919, manipulation under anesthesia. Thirty degrees of motion obtained followed by considerable joint reaction.

Case 7. A. L. End result.

DISCUSSION.

On December 29, 1919, patient was examined by the author and was not thought to be a suitable case for operation, as it was the author's opinion that there was an active arthritis. The point was brought up by Dr. V. P. Gibney, that if contraction of the quadriceps tendon occurred from immobilization in extension from fractures, etc., the same could occur from immobilization from inflammatory lesion. In his opinion there was no active arthritis in this case.

At the request of the patient a lengthening of the quadriceps was done on December 30, 1919 (by method shown in cuts demonstrating operation). With very little effort the knee was flexed to a position of 90 degrees, after the tendon had been detached. It was the opinion of the author at this time that a violent reaction would be started in the knee by operation. So he attempted to keep on the safe side by sewing the tendon, and fixing it in a position of forty-five degrees, instead of the usually eighty degrees of flexion.

At the request of the author an early inspection of the leg was made and passive motion begun. The author was surprised to hear that only a moderate joint reaction had occurred. Under rather vigorous manipulation and post-operative treatment this patient made a good recovery, and on October 21, 1920, has approximately ninety degrees of painless motion (as shown in illustration) and walks without limp.

This case demonstrated clearly the two points made by Dr. Gibney:—that there was no active arthritis in this case, and that a contraction of the anterior thigh group is sometimes associated with immobilization from inflammatory disease of the joint, as well as from extra-articular lesions. It is the opinion of the author that the operation should not be done unless one is sure that no active inflammation is present.

Case No. 8. R. C. W. Age 30. White male. Admitted to Johns Hopkins Hospital, January 8, 1920. Discharged April 6, 1920.

Family History: Unimportant.

Past History: Unimportant.

Present Illness: October 15, 1918, was struck in the right hip with a piece of high explosive shell and sustained a fracture of the ilium and anterior hip joint. Was operated on twenty hours later and foreign bodies removed. December, 1918, operation on the right hip joint with immobilization. At this time there was no evidence of any lesion about the knee joint or foot. Leg immobilized in plaster which was removed on February 15th, with many excoriations—knee stiff and foot drop.

Thomas splint was then applied for a period of four weeks, followed by second immobilization in plaster. During this time there was considerable discharge from the hip joint. In May, 1919, several abscesses were opened down the thigh extending to a few inches above the knee. Hip joint and all draining sinuses were cleared up by July 10, 1919, leaving a painful knee joint and toe drop.

Physical Examination: Patient complains of stiff knee and hip. The right hip is absolutely ankylosed in full extension, in neither abduction or adduction, and in neutral position as far as rotation is concerned. There are numerous scars of old incisions about the hip. One of these over the front of the thigh seems to be attached to the bone at about the level of the junction of the middle and lower thirds. The knee joint is likewise in full extension, but permits of a few degrees of flexion, so as to rule out bony ankylosis. Passive flexion stops when the tissues below the scar mentioned become taut. Active efforts at extension are likewise visibly embarrassed by the attachment of the quadriceps at the scar. Palpation of the knee joint reveals considerable tenderness to pressure over the anterior portion of the internal semilunar cartilage. No abnormal lateral mobility is obtained. The patella is freely movable.

Neurological note. January 10, 1920.

Apparently the ham string muscles are active. Internal stronger than the external. Below the knee the calf muscles act strongly in extension. Can flex the ankle with fair strength. No evidence that the popliteal muscles are active. No movement of the great toe on extension. Ankle reflex active. There seems to be some numbness over the dorsum of the right foot. Nowhere is there absolute loss of sensation.

Impression: Case impresses me as a recovering pressure paralysis of the external popliteal nerve.

Operative Note: Lengthening of the quadriceps tendon for loss of motion in the right knee.

Iodine skin technique. An anterior longitudinal incision was made on the right thigh from its middle third to the knee joint, and deepened to expose the quadriceps tendon. The skin and subcutaneous layers were then dissected up to either side, so as to show the superficial component parts of the muscle at their tendinous insertions. The rectus femoris was cut transversely at its point of union with the tendon, the ends of the incision being carried down to the patella on their respective sides, in such a way as to sever the connection of the tendon from the vasti muscles. The tendinous flap was dissected up from the underlying bone to the level of the upper part of the patella. Very little force was

then needed to flex the knee joint, but in doing this the capsule, which was very adherent, was torn. After the first manipulation was made the normal movements of the knee from full extension to almost 70 degrees of flexion were obtained freely. Considerable bleeding from the capsule was encountered. The knee was held flexed 80 degrees and the patellar tendon, being drawn up as far as possible in flexed position, was resutured to the vasti with kangaroo tendon. The gap left between the upper end of the tendinous flap and the rectus femoris, about an inch long, was closed by drawing together the lateral borders and suturing them with kangaroo tendon. Subcutaneous layers were then closed with plain catgut and skin with silk. A plaster knee cast was applied with the leg in 80 degrees of flexion. The patient lost a fair amount of blood, but stood the operation well.

DISCUSSION.

The notes on this case are of particular importance, since this case marks a failure. The clinical and X-ray examinations showed definite knee joint changes, with some local reaction in the knee, at the time of operation. This young man was in such a pitiable condition, with an ankylosis of the hip, only a few degrees of motion in the knee, and an external popliteal paralysis, that an attempt was made to relieve the evident adhesions in the thigh. His post-operative findings show that we had irritated an inflamed joint, and caused marked reaction, with the result that at the present time he has 30 degrees of painful motion. In post-operative treatment he sustained a fracture through the condyles due, probably, to rather vigorous massage to a joint that had not functioned in fifteen months and was very atrophic.

I believe the reporting of this case to be as important as any of the series, and hope that perhaps the report will prevent others from attempting an operation of this type on very atrophic and actively inflamed joints.

SUMMARY.

Certain rather definite findings are to be noted. First:—contraction of the quadriceps without adhesions will produce a loss of function of the knee.

Second:—contraction and adhesion between the muscles themselves, or between muscle and bone, will produce loss of flexion of the knee.

Third:—the capsular changes are not as constant a finding as the muscular changes. Knee joints that cannot be forcibly flexed before the releasing of the tendon can be easily flexed afterwards.

Fourth:—contraction of the muscular tissue following long immobilization for inflammatory knee joint disease, probably is present, but it is not advisable to operate in the presence of a sensitive joint.

Time is an important factor. It is better to operate on a patient who has walked for five years with ten degrees of motion, than on one who has walked for five months with thirty degrees of motion. In the former, joint and muscle tissue are in good tone: therefore, they lend themselves better to operation and they return to function much more rapidly.

DESCRIPTION OF OPERATION.

Patient should be placed in a position to allow free movement of the leg, and to permit flexion to 100 degrees. This can be most easily accomplished by extending the leg over the end of the operating table.

A straight incision is made on the anterior surface of the thigh, extending from the middle of the patella to approximately the junction of the central and lower thirds of the femur, passing through the subcutaneous tissue and fascia. A lateral blunt dissection gives an exposure of the vasti, the attachment of the rectus, and the capsule of the knee joint. If adhesions are present, exposure should extend to a point at least two inches above, permitting a thorough inspection of the entire field.

When dealing with a simple contraction not associated with adhesions of the tendon and muscle to the femur, only the tendinous section is cut free from its muscular attachments. This is accomplished by a linear incision on each side of the tendon, extending from the attachment of the rectus femoris to the patella, following closely to the muscle margin, and broadening at the patella, leaving its normal strong attachment at this point. These parallel incisions should be deep enough to include the tendinous section of the vastus intermedius (crureus) (see Fig. No. I). These are connected by a short incision and the entire tendon is dissected free from the underlying structures, from the rectus to the patella (Fig. II.) With the tendon completely detached from its muscular attachments, the knee is carefully flexed, cutting any adherent points in the capsule, or about the lateral margin of the knee. Flexion is carried to a point of at least ninety degrees. The leg is then brought to a position of eighty degrees of flexion, and the tendon re-attached to its muscle at this level, as shown in Fig. III, by means of kangaroo tendon or heavy braided silk.

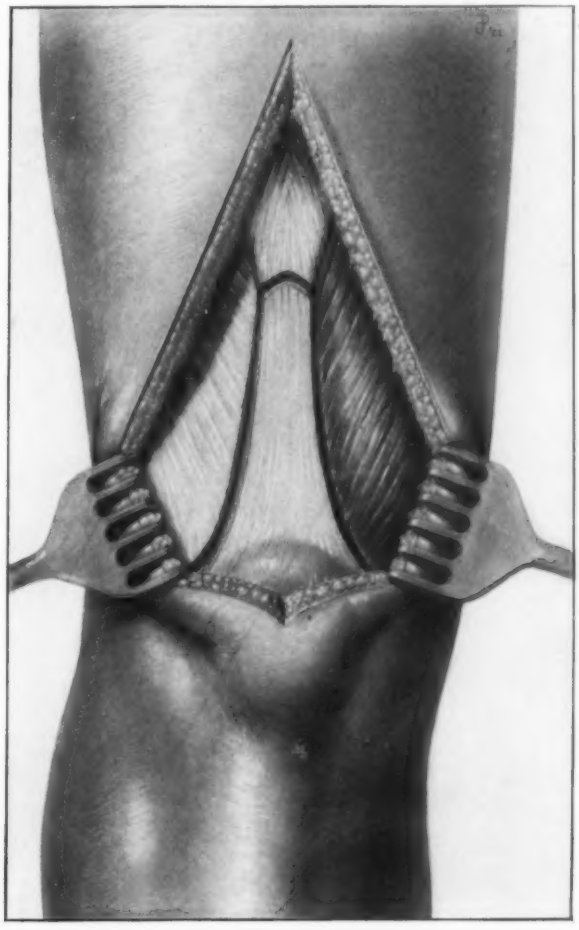


FIG. I.

In the presence of marked adhesions in the lower thigh, it may be necessary to dissect the vasti free from the femur, thus permitting them to be drawn toward the median line, and attached to the tendon. If necessary, fascia or fat can be placed between the bone and the muscular structures. With the tendon in its new position, a space is open at the lower end of the rectus (Fig. IV). This is closed by mattress suture through the vasti.

The operation as above described has been modified by attaching the muscle to the tendon at different levels, and by utilizing the tendon

FIG. II.

fibres of the rectus to fill in the space mentioned above. But this complicates the operation and does not hasten the convalescence or improve the end result. However, occasionally one finds a rectus tendon that is independent until it reaches a point about one inch above the patella, where it becomes a part of the quadriceps. When this occurs, it is well to cut it free at its lowest point, retract, and proceed with the operation as described. After the lengthening, the rectus tendon is then attached to the quadriceps. The fasciae are closed with catgut and non-absorbable skin suture. Plaster of Paris is used to immobilize in a position of eighty degrees of flexion for a period of three weeks. The plaster dressing is

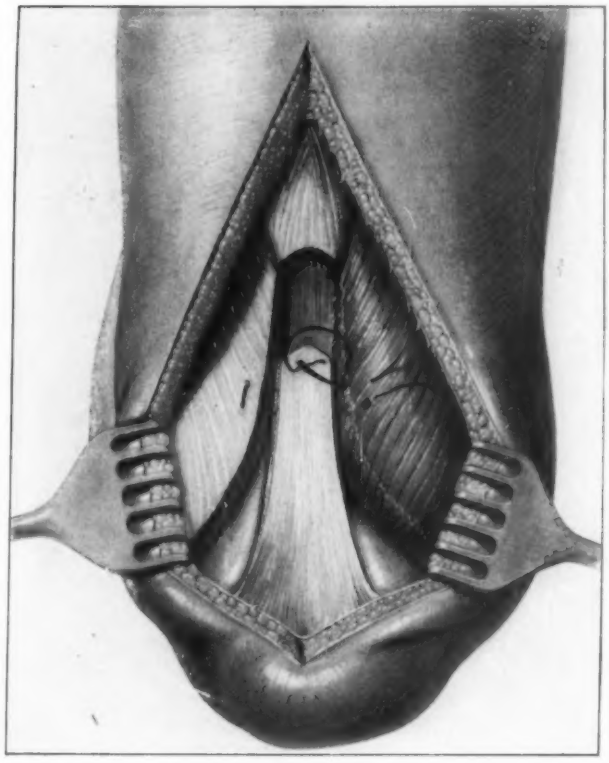


FIG. III.

then cut, removing the upper half, and passive motion is begun. Gradual passive extension of the knee is then begun during the day, and the knee is placed back in the splint in its flexed position at night. At the end of the fourth week the author encourages active contraction of the muscles with the leg held firmly in an extended position. In mild cases active use of the leg during the fifth week is advised, and the patient is encouraged to walk with crutches and bend the knee to its full extent, but not to place any weight on it. Active extension of the knee when in a standing position is also encouraged, but care should be used in the effort to extend the leg when in a sitting position. Massage is usually begun at the end of five weeks, but should be mild until all of the acute trauma has subsided.

A common post-operative finding is an extreme degree of ecchymosis on a part or the entire anterior thigh. Particularly is this true in the

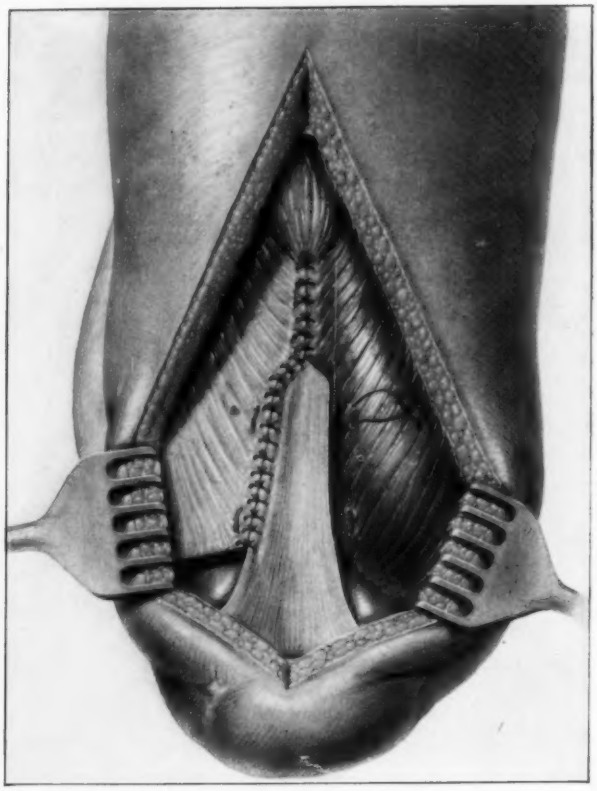


FIG. IV.

cases with adhesions as well as contraction. No skin necrosis has occurred in any of the cases.

The return of power to extend the leg to a normal position is slow, particularly the last fifteen degrees, and in some instances was not accomplished until a year after the operation. The quadriceps tendon often cannot be palpated for two or three months, but gradually fills in and becomes normal in size.

Since the writing of this paper, approximately one year ago, the author has operated on four additional cases, all of which have recovered with not less than ninety degrees of motion.

PRACTICAL THOUGHTS ON BONE PEGS, BONE SCREWS, ETC.

HARVEY C. MASLAND, M.D., PHILADELPHIA.

RECENT literature relating to bone screws and bone pegs inclines me to believe that certain practical principles underlying their use have not been appreciated. There is indication that operators are having difficulty in the easy utilization of these valuable aids. Their inability to make and use pegs and screws quickly, easily, and with perfect certainty of accomplishment has delayed the recognition of the fact that pegs and screws are the logical and the best binding material we have in the vast majority of cases for plastic bone work.

In my experiments in the cutting of small-diametered pins I quickly found that the high speed universal motors burned and burnished all the pins made. The dowelling tools commonly used have numerous shallow cutters. These quickly choke, then chafe, with the result that seventy-five per cent. of the bone pins are broken in the making.

I substitute a low speed selective current motor. Instead of the fourteen cutters on the dowelling tool I use three. This combination will cut a bone cylinder one and a half inches long in a few seconds with no heat, binding, or breaking.

In the making of bone screws the gauge of the tools that are correct in a machine shop for metal is worthless. It is not practical to attempt to cut on bone as deep and clean a thread as can be made on iron. Unless such a thread be cut in successive stages the bone will inevitably break. Further, such a screw is difficult to turn into a threaded bone hole without binding and breaking. I made my dowelling tool of such a gauge that the die will cut a sufficiently deep thread by hand. By hand this screw can be turned into a threaded hole and have sufficient bite to hold rigidly for all practical purposes. The head of the screw is nothing but the rough uncut end of the bone pin. With the fingers or a hemostat it can be handled both in its manufacture and its use. One bone screw one and a half or one and three-quarter inches long is sufficient for four holes. It is turned through the compact layers of the first holes, cut off flush and so utilized for the remaining holes.

There are certain underlying principles that should decide us as to whether bone screws or bone pins should be used. It might be put in the form of a general statement that where the strain is along the line of insertion a bone screw should be used. Where the strain comes at an

FIG. 1.—The point of the bone strip placed in the bore of the dowelling tool. Start the point right to make a true cylinder.

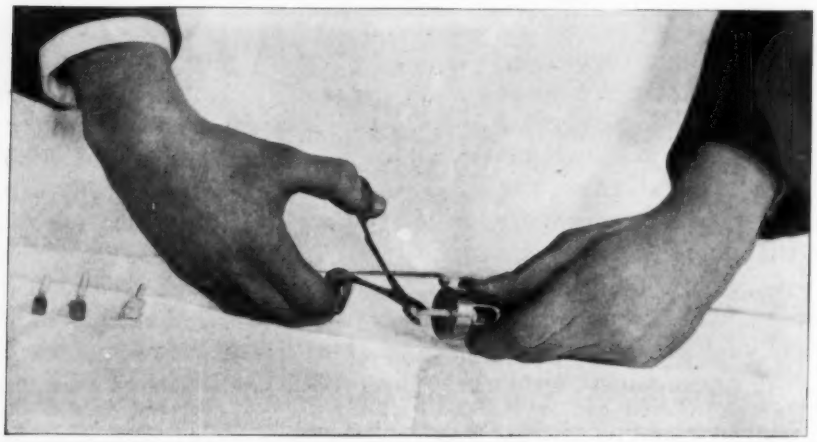


FIG. 2.—Cutting a thread on a bone pin. Fresh bone is less likely to chip.

angle a bone pin is most practical. Where a bone plate is applied after the Lane method bone screws should be used. In a bevelled slide graft, however, the drill should be directed to catch the margin of the graft and penetrate the compact bone of the shaft to be plated at a transverse

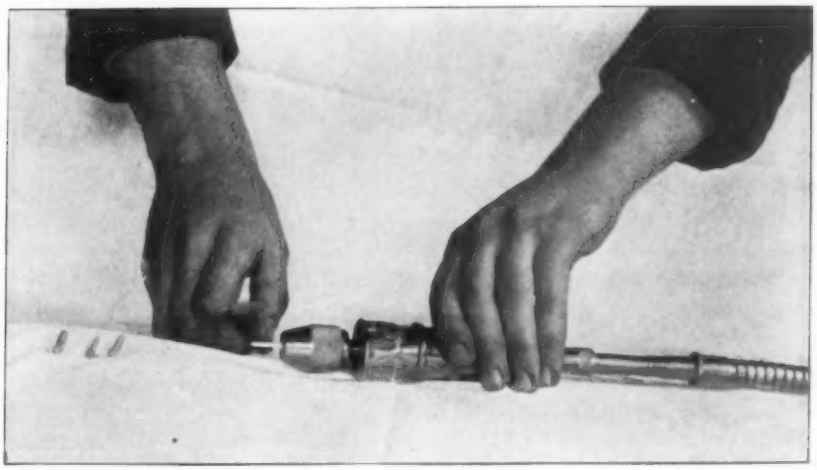


FIG. 3.—The bone pin is engaged in the chuck tool and can be filed down to any desired diameter.

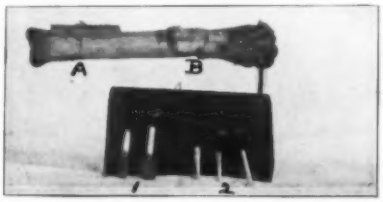


FIG. 4.—A, Bone plate and bone screws holding fracture. B, Slide graft with appropriately reduced bone pins obliquely placed at the margins of the graft. 1, bone screws. 2, bone pins.

oblique angle. The bone pin need be just a snug fit under such conditions. Pressed into place by hand the cross strain against it will hold it and the graft in place.

The dowelling tool in my equipment makes a pin that allows for a thread and would, therefore, be too large for the drill that makes a hole requiring a mating thread. To make the pins fit the hole made by the drill the bone pin is fitted into the chuck tool and while rotated by the motor is filed down to the diameter desired.

This ability to turn the bone pins down to any smaller diameter is valuable where we have the smaller bones of the limbs to operate upon. One would not use the same size bone pins in plating an ulna that he would use for a femur.

In the tool holder which I use, drills, taps and dies of varying diameters can be procured from the nearest hardware store. These unnickelled tools are really superior cutters in that their edges have not been dulled by the deposit of nickel. Quick drying and oiling is all that the unnickelled tool needs to preserve it a better instrument. I would emphasize here the necessity of requiring of the nurse proper after care of bone instruments. Some of the tools are expensive. Incomplete drying and oiling will in a short time damage an instrument that should last indefinitely.

The objection will be raised that this class of bone work is nice theoretically but is not practical. This is because we have not submitted ourselves to learn the practical way. It is surprising how quickly these things can be done at the operating table with a proper equipment and the acquisition of the necessary technique. In this connection, however, I feel that the making of bone pins or screws at the time of operation is quite unnecessary. I look upon bone pins and screws solely in the light of suture material. There is no valid reason why they cannot be heterogenous. One can make a supply of beef bone screws and pins of varying diameters and threads at his leisure. This is a saving of time and of autogenous bone. These can be cleaned, boiled, and kept sterile until needed.

Finally, the different power equipments now supplied offer varying degrees of facility in operation, but none of them should be used till the operator learns how to use them. Those who are willing to learn how to use and how to care for these modern equipments will be amply repaid in the increased facility at operation and the quality of the work performed.

THE STANDARD PLASTER BANDAGE.

BY WILTON H. ROBINSON, M.D., PITTSBURGH.

WHEN applying a plaster cast one wishes it to look well and to be efficient. With other minor considerations, it should be of an even thickness throughout (except at those places where it is reinforced) and all layers should cohere closely. It is difficult to obtain these two most important considerations unless the bandages are properly made. It seems to the writer that a very important factor in consistent plaster work is uniformity of the bandages used. This uniformity may be obtained and maintained by the occasional use of a scale to weigh the completed bandages. It is not necessary to weigh each bandage, as the person doing this work easily becomes familiar with the standard bandage in each size. Any scale which has a capacity of from one to sixteen ounces will do.

The following table of lengths and weights has been found satisfactory:—

Two inches wide by one yard long should weigh two ounces.

Four inches wide by four yards long should weigh eight ounces.

Six inches wide by four yards long should weigh ten ounces.

Each bandage is wrapped in a paper napkin, except the two-inch size, for which one-quarter napkin is sufficient.

A CASE OF SPONTANEOUS FRACTURE OF THE TRANSVERSE PROCESS OF A LUMBAR VERTEBRA—DUE TO TUBERCULOSIS.

BY BEVERIDGE H. MOORE, M.D., CHICAGO, ILLINOIS.

THE following case presents unusual features which seem to justify reporting it.

H. McC., negro, male, aged 27 years, was first seen at the Orthopedic Clinic at Northwestern University Medical School, on November 29, 1920. His complaint was pain in the left thigh and lumbar region. It had come on suddenly about four months previously while he was doing some light work at a grinding machine. There had been no unusual strain nor could he recall any trauma.

The pain at the onset was so severe that he was unable to stand or walk, but this severe pain gradually left, and was replaced by a dull aching pain which had persisted. A few weeks after the onset, he noticed that the left thigh and leg were becoming weaker than the right, and he thought they were "falling off" in size.

The pain complained of radiated down the inner side of the thigh to the knee. Walking or stooping caused severe pain to shoot down the thigh.

The family history and previous history were unimportant. He had lost some weight but had had no night sweats or cough.

Examination showed a muscular young negro.

The spine showed the normal antero-posterior curves. In the left lumbar muscles there was a swelling near the spinous processes, which gave deep fluctuation but was only slightly tender. There was no local heat. No spasm of these muscles was present.

The entire spine showed a slight list to the right.

Forward, backward, and lateral bending all caused severe pain which radiated down the thigh. Lateral bending to the right caused specially severe pain.

Both hips and knees showed normal motion, passively. Active flexion of the left hip, especially against some resistance, caused severe pain both in the back and the thigh.

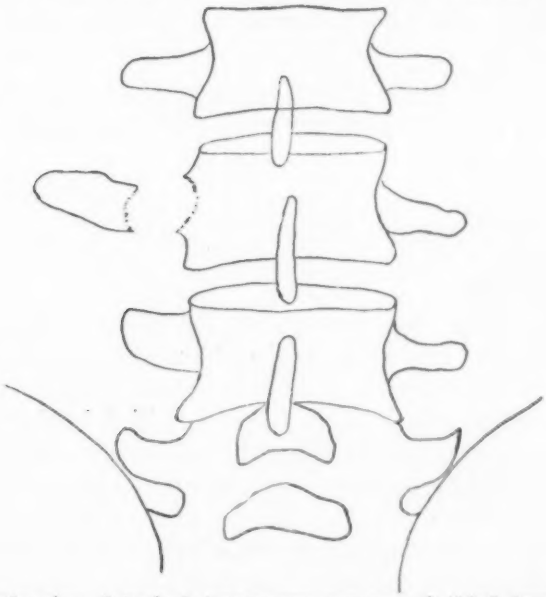
The left thigh was one inch smaller than the right and the calf was ¾ inch smaller than the right. There was decidedly less strength in the muscles of the left thigh and leg.

X-ray showed the entire transverse process on the left side of the third lumbar vertebra separated from the vertebral body and lying about 1 cm. from it. The bodies of the vertebrae and the intervertebral discs appeared entirely normal.

The patient was referred to Cook County Hospital, where he was admitted to the Orthopedic Service on December 8, 1920.

The swelling in the lumbar region had increased somewhat in size and was more fluctuant. It was aspirated and a thin grayish pus

Showing abscess pointing in left lumbar region, and atrophy of left thigh.



X-ray tracing showing detached transverse process of third lumbar vertebra.

containing flocculent material was removed. This was sterile on culture, and a guinea-pig was inoculated.

The abscess was opened and drained. The transverse process was found lying free in the abscess cavity and was removed.

The appearance of the pus in the abscess cavity was typically tuberculous.

After the removal of the bone fragment and the evacuation of the abscess the leg pains ceased. A sinus opened in about three weeks which drained profusely.

Later the patient began to lose weight and developed signs of a generalized miliary tuberculosis.

He died on March 31, 1921.

Autopsy was performed by Dr. D. J. Davis, on April 5, 1921.

There was a marked miliary tuberculosis of practically all the internal organs. The lungs, liver, spleen, adrenals, kidneys, pancreas, peritoneum, and brain showed miliary tubercles and caseous nodules.

The bodies of the third and fourth lumbar vertebræ showed considerable necrosis, and appeared to be full of minute foci which had not yet coalesced. The first and second vertebrae showed the same process but in a less advanced stage.

The sinus in the lumbar region was characteristically tuberculous, with its base at the root of the affected transverse process.

Sections of the bone were characteristic of tuberculosis.

It seems fair to conclude that the primary bone focus in this case was in the transverse process, since this lesion was much more advanced than the process in the vertebral bodies.

The weakened process probably gave way under some slight muscular strain.

Tubby, in his book on "Deformities," speaks of the transverse processes being a rare location of the tuberculous process but he does not cite any cases.

Speed, in his book on "Fractures," cites several cases of fracture of the transverse processes. These were all, except one, due to muscular action, but no mention of any previous pathological process in the bone is made.

The symptoms are easily accounted for on an anatomical basis.

The radiation of the pain to the thigh and knee is due to pressure either of the fragment or of the abscess on the obturator nerve, which takes its principal origin from the third lumbar nerve.

The pain on flexion of the hip is probably due to the action of the psoas muscle, which has one origin from the transverse processes of the lumbar vertebrae.

While rare, tuberculosis is a condition to be considered in fractures of the transverse processes. Aspiration, in the cases which show fluctuation, is useful in differentiating between hematoma and abscess.

SUBASTRAGALOID EXTERNAL DISLOCATION.

BY ELLIS JONES, M.D., LOS ANGELES, CALIFORNIA.

LATERAL subastragaloid luxations of the foot to the outer side are not common. A review of the literature indicates that their pathological anatomy has been reconstructed for the most part on the basis of the clinical findings, and it is not surprising, therefore, that the mechanism of this displacement is disputed and the causes of its irreducible behavior are variously explained.

Recent textbooks on fractures and dislocations make bare mention of the subject. To Verneuil,[1] Poinsot,[2] Quénu,[3] Broca,[4] Malgaigne,[5] Nélaton,[6] Cowell,[7] Kaufmann,[8] Deetz,[9] Thienhaus,[10] and Lossen[11] the student is referred for modern light on an ancient subject. Quénu ascribed a failure of reduction to the interposition of an intact annular ligament between the articular cavity and the head of the astragalus. Cowell explained the mechanism of the dislocation as being identical with the ordinary Pott's fracture. Pick[12] ascribed the difficulty of reduction to displacement of one or the other of the tibial tendons behind the neck of the astragalus.

Broca and Poinsot collected twenty-three simple cases of all types of subastragaloid dislocations in which reduction was attempted. Reduction was successfully accomplished in fourteen, and the ultimate result was good; in two, the reduction was incomplete, and one of these died of septicaemia. There were four secondary amputations with three deaths, three secondary removals of the astragalus with one death, and one good functional result, notwithstanding the persistence of the deformity.

In seven additional cases in which reduction was not attempted, four of the patients had apparently good function. In one case reduction was made after six months; in two cases the disability was such that the patient sought relief; Sinnigen[13] removed the astragalus and external malleolus, and at the time of the report death by septicaemia was expected; Raffa[14] chiselled away the head and the neck of the astragalus and was then able to straighten the foot; recovery without suppuration; good result.

In two cases primary excision of the astragalus was done with good results. In Verneuil's there was fracture of the astragalus and rupture of the peroneal artery; in Oré's[15] an attempt to reduce had failed and gangrene of the tense skin was imminent.

Of compound dislocations seventeen cases were collected by Broca and six additional by Poinsot in 1884; and to these, two cases reported by Jackson[16] and Stimson[17] are to be added. Of these, reduction was

made in eleven, with two deaths, with persistent suppuration in two, and with secondary removal of the astragalus in one. In fourteen reduction was not made; in three of these primary amputation was done, in ten, removal of the astragalus, with two deaths, and in one the head of the astragalus became necrosed and was spontaneously extruded, the patient recovering. The results of primary removal of the astragalus are rather better than those of reduction, but the value of these statistics as a basis for the choice of a method of treatment has been greatly diminished, as Stimson suggests, by the improvement in the methods of treatment of open wounds that has taken place in the last few years.

More recently (1913) Viannay[18] and Fayard[19] observed two cases of subastragaloid luxation of the foot outward. In the first case an astragalectomy was required on account of the irreducible character of the lesion. In the other case reduction was obtained on the day of the accident by manipulation so planned as to first exaggerate the luxation by hyper-abduction and a reduction by sudden forcible adduction of the foot.

The above statistics emphasize the seriousness of the lesion and the need of early reduction and appropriate treatment in this type of dislocation.

The forms known as dislocations backward, inward, and outward of the os calcis and scaphoid from the astragalus were recognized in Broca's plan of sub-division. Malgaigne added a fourth variety, dislocations forward. The dislocation thus presents four varieties, occurring at the astragalo-scaphoid and astragalo-calcaneoid joints: displacement of the os calcis and scaphoid inward and somewhat backward, with the head of the astragalus projecting on the outer part of the dorsum of the foot, their displacement directly forward or backward and downward and finally their displacement outward. The occurrences of the first two varieties, while uncommon, are of equal frequency and comprise the greater number of cases. The last two varieties are of less frequent occurrence.

Two varieties of the dislocation outward have been described clinically by Malgaigne, distinguished by marked abduction of the toes in one and its absence in the other. It is possible that such a clinical distinction is based upon the degree of the dislocation itself rather than indicating a distinct variety.

Recent opportunity for a study of the mechanism, pathological anatomy, clinical and radiographic findings, was afforded the writer in the study of the following case of subastragaloid external dislocation complicated by fracture of the neck of the astragalus.

PLATE 1.—Subastragaloid external dislocation with comminuted fracture of neck of astragalus.

PLATE 2.—Subastragaloid external dislocation with comminuted fracture of neck of astragalus.

PLATE 3.—Subastragaloid external dislocation after reduction.

J. T., male, aged 39. Examination, October 6, 1920, three days after accident. Patient had fallen sixty feet into arroyo, striking on left foot. The local physician had attempted reduction, believing the injury a Pott's fracture. The foot was in extreme valgus with the concavity of the sole obliterated and a well-marked depression admitting three finger tips under the internal malleolus where the edge of the inferior margin of the body of the astragalus was easily palpable. The relation of the body of the astragalus to the internal malleolus was unchanged and this sign, together with the extreme valgus, was sufficient for the clinical diagnosis of external subastragaloid luxation. The skin over the head of the astragalus was taut and ecchymotic and lacerated where the patient had attempted with pocket-knife incisions to relieve the pain of internal bleeding. Beneath the skin, over the front of the ankle joint, was a firm, hard tumor, presumably the head of the astragalus. Flexion and extension were demonstrable at the ankle, but the foot was held in rigid equino valgus. Stereoscopic radiographs (Plates 1 and 2) confirmed the diagnosis. Reduction was easily obtained, after a tenotomy of the tendo Achillis, by direct skeletal traction with a Steinmann pin through the tubercle of the os calcis (Plate 3). The comminuted fragments of the head and neck of the astragalus were excised through an anterior incision. The astragalo-scaphoid ligament was found intact. Carrel-Dakin tubes were introduced and the patient given an immunizing dose of tetanus antitoxin.

PLATE 4.—Astragalectomy following external subastragaloid dislocation.

On the third day, because of extending infection, a curved incision was made over the internal malleolus and extending to the base of the internal cuneiform bone. A four-inch external incision was made similarly from the external malleolus to the head of the fifth metatarsal and Dakin tubes placed. Culture showed streptococcus haemolyticus in almost pure culture. The convalescence was stormy and the temperature ranged from 97 to 105. At no time was a sterile count obtained and the radiographs showing an increasing necrosis of the astragalus, an astragalectomy was done on November 29th. Thereafter, convalescence was relatively uneventful, and a sterile bacteria count was obtained on the eighteenth post-operative day. A transfusion was done because of a haemoglobin of 38% and red cells of 3,200,000. No attempt at wound closure was made and on January 10th all wounds were healed and Bristow coil work and physiotherapy were begun. Five months after the original injury and four months after the astragalectomy, the

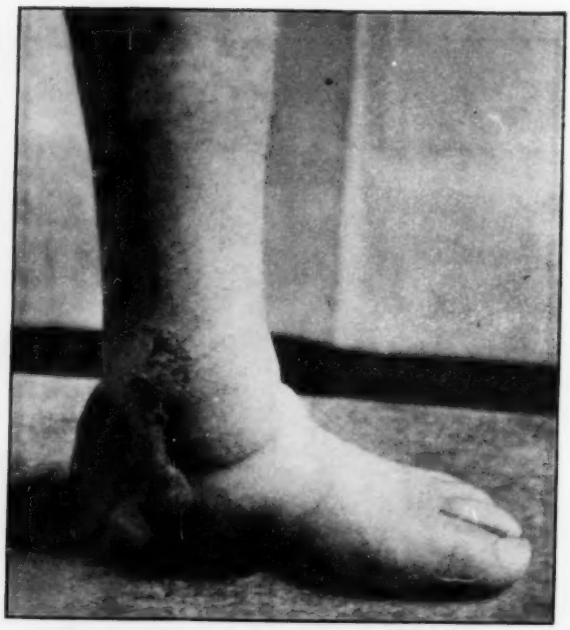


PLATE 5.—End-result after astragalectomy.

PLATE 6.—End-result after astragalectomy.

patient walks with a cane and slight limp, with function increasing and with 25° of motion in the ankle joint (Plate 4).

Astragalectomy furnished little opportunity for study of the lesions complicating the dislocation. The extensor and peroneal tendons were in their proper places. The internal lateral ligament and the anterior annular ligament were intact. It is difficult to conceive how either the extensor or peroneal tendons could act as obstacles to reduction.

In experiments on the cadaver the writer was able to reproduce subastragaloid external luxations in the following manner. The foot was placed in strong pronation. In this position the astragalus butts against the post-surface of the anterior process of the os calcis, the joint gaping inwards. The astragalus is now enabled to move or luxate over the os calcis and from the hollow of the scaphoid inwards. An increase in the forced pronation, together with forcible eversion of the os calcis, completes the dislocation. It was possible to obtain fracture of the neck of the astragalus (as in the writer's case) only by direct violence while forced and rigid pronation was being maintained.

A few practical conclusions seem justified:

The mechanism of external subastragaloid dislocation is that of strong pronation with eversion.

Apparently, tenotomy of the tendo Achillis facilitates reduction of a subastragaloid external dislocation and permits easy lateral replacement of the dislocated os calcis. Traction on the os calcis should be accompanied by strong supination of the fore foot.

In a compound fracture-dislocation, early astragalectomy should be considered because of the almost inevitable necrosis of the astragalus.

REFERENCES.

1. VERNEUIL: Bulletin de la Société Anatomique, 1872, p. 493.
2. POINSOT: L'intervention chirurgicale dans les luxations compliquées du coup-de-pied, Paris, 1877.
3. QUÉNU: Progrès Médical, 1894, xix, 25, p. 385.
4. BROCA: Gaz. Hebdom., 1874, p. 316.
5. MALGAIGNE: Quoted by Stimson, Fractures and Dislocations, 1910, p. 845.
6. NÉLATON: Bull. de la Soc. Anatomique, 1835, p. 38.
7. COWELL: Lancet, 1892, i, p. 138.
8. KAUFMANN: Zentralblatt für Chir., 1888, p. 369.
9. DEETZ: Deutsche Zeitschrift für Chir., vol. lxxiv, p. 581.
10. THIENHAUS: Annals of Surg., Feb., 1906, p. 295.
11. LOSSEN: Deutsche Chirurgie, Lieferung 65, 1880, p. 204.
12. PICK: Lancet, 1880, vol. 1, p. 170.
13. SINNIGEN: Quoted by Stimson, p. 849.
14. RAFFA: Zentralblatt für Chir., 1885, p. 211.
15. ORÉ: Quoted by Stimson, p. 849.
16. JACKSON: Lancet, 1881, ii, p. 590.
17. STIMSON: Page 849.
18-19. VIANNAY AND FAYARD: Révue de Chirurgie, 1913, vol. xlvii, p. 273.

HYPERTROPHIC BONE CHANGES IN TUBERCULOUS SPONDYLITIS.

BY ROBERT B. COFIELD, M.D., CINCINNATI, OHIO.

From the Orthopædic Department of the Cincinnati General Hospital.

TUBERCULOUS osteitis has generally been considered a destructive pathologic process producing a carious degeneration with little or no tendency toward bone regeneration during the acute or active stage of the disease. Limitation of the destructive process is usually controlled by the formation of fibrous tissue, into which the deposit of lime salts is strikingly absent. Some observers[1] contend that ankylosis of tuberculous joints is always fibrous, bony union never taking place, except after a resection of the joint, or in children after a mixed infection has occurred. Tuberculous spondylitis affecting the bodies of the vertebræ has been no exception to this rule and, until a comparatively recent time, the author has been inclined to doubt the diagnosis of spinal tuberculosis in those cases in which hypertrophic bone changes were shown to exist during the acute stage of the disease.

LITERATURE.

The literature dealing with tuberculous spondylitis has been searched in vain for any accurate description of this condition. John Fraser[2] states "that it is an interesting fact, and one which has never been explained, that in tuberculosis of the vertebræ the periosteum rarely forms any degree of new bone." However, it has long been a common observation that bony ankylosis of the vertebræ does often occur in the later stages of those cases in which sinuses have existed for some time and in which secondary infection has been allowed to creep in.

Willis C. Campbell[3] reports four cases of localized spondylitis in which the roentgenograms show crescent-shaped lamellæ of bone extending from the body of one vertebra toward its adjacent fellow and which may completely encapsulate the disk, producing a solid external fixation of the two vertebræ. His conclusion is, that the etiologic factor is probably the same as in monarticular osteoarthritis, and while he does not rule out the possibility of a tuberculous infection in all his cases, he evidently does not consider it likely that he was dealing with tuberculous spondylitis in which hypertrophic bone changes had taken place.

French contributors have described a condition, under the caption of *Spondylitis rhizomélique*, which occurs in phthisical subjects in whom the whole spine slowly becomes stiff and fixed throughout its entire length. A. H. Tubby[4] considers that this form may be a *superficial caries* of the bodies of the vertebræ which is accompanied by inflammatory and osteophytic changes in the intervertebral articulations. He is inclined to believe that this type is a discrete tuberculous infection of the entire spinal column.

CLINICAL CONSIDERATION.

A study of one hundred consecutive cases of tuberculous spondylitis occurring on the orthopædic service of the Cincinnati General Hospital has disclosed ten subjects in whom hypertrophic bone changes were present during the active stage of the disease. The condition in five patients was confined to monarticular lesions, the other five showing two or more attempts at bony bridging in contiguous areas of the spine. In six of the ten subjects a cold abscess was present, but in only one had drainage of the abscess been performed previous to the roentgenologic examination and therefore the possibility of extraneous infection could be eliminated. In the six patients with cold abscesses, aspiration or drainage operations were performed and typical tuberculous pus was evacuated. Hypertrophic bone changes have invariably been confined to individuals over twenty years of age and have accompanied lesions located in the lower dorsal, dorsolumbar, and lumbar vertebræ. This would indicate an effort to limit motion, as a part of the healing process, in these regions of the spine which sustain the strain of greatest weight-bearing and motion. Only those subjects in which the least possible doubt existed concerning the tuberculous nature of the disease have been included in this study, and while it has been difficult in many instances to secure confirmatory laboratory findings in all cases, there were two with abscess in which the tubercle bacillus was found in the pus and positive inoculation of the guinea-pig was performed. In five of the subjects there was positive evidence of pulmonary phthisis and in *none* was there a positive Wassermann reported. Seven patients have improved with conservative orthopædic treatment, which has included immobilization of the spine with some external fixation; three have died following complications.

GROSS PATHOLOGY.

From one subject who died and came to autopsy, the spine was removed and careful dissection made (Case No. 6). There was a large sinus on the right side leading into the body of the second lumbar vertebra; the entire lumbar spine was rigid, no collapse having taken place. Hypertrophic bone changes were found extending from the second to the third lumbar vertebra, both anteriorly and laterally. Further dissection revealed that the twelfth dorsal was firmly fixed to the first lumbar and that the second, third, and fourth lumbar were firmly ankylosed by periosteal over-production of new bone, all of which did not appear distinct in the roentgenogram. The lamellæ of new bone took the same course as the ligamentous fibers of the anterior and lateral spinal ligaments, the fibers being firmly attached to the hypertrophic bone formation, suggesting the possibility that the new bone deposit had occurred within the ligaments, to some extent at least. The body of the second lumbar vertebra showed an extensive carious degeneration. A firm ankylosis was produced embracing that section of the spine extending from two vertebræ above the tuberculous lesion to two below. The entire specimen very strikingly portrayed a natural attempt toward spinal fixation such as we attempt to produce surgically, either by the spinal fusion operation of Hibbs or by the Albee bone graft.

CONCLUSIONS.

Tuberculous spondylitis shows a natural attempt toward spinal fixation by hypertrophic bone changes in at least ten per cent. of cases.

This natural attempt toward spinal fixation by bony bridging is most likely to occur in that portion of the spine in which there is the greatest freedom of movement, *i. e.*, the lumbar region.

Bony ankylosis of the spine may occur in tuberculous spondylitis without the presence of a mixed infection.

It is possible that many cases of spondylitis, diagnosed monarticular osteoarthritis, are of tuberculous origin.

This condition has not been found, except in those who have attained adult age.

Since spinal fixation has long been considered the most rational treatment for tuberculous spondylitis, and since bony fixation occurs naturally in a certain percentage of cases, it would seem justifiable

to recommend internal fixation by bone graft or spinal fusion as a most rational aid toward recovery, especially in the adult.

CASE REPORTS.

CASE 1.—A-5716. Age 29, saleslady. Admitted, August 23, 1916; discharged, December 18, 1917.

Complaint—Swelling in the back and thigh.

Family History—Negative, except one sister died at the age of three months of pneumonia. No history of tuberculosis in family.

Past History—Diphtheria at the age of six, typhoid at eighteen, otherwise always been well.

Present Illness—Began five years ago with severe cramps in the lower region of the abdomen. Was operated on for a strangulation of the bowel at this time. Eight months afterwards a large abscess formed in left groin and was drained. Six months later another abscess formed in the lumbar region which was drained. Wassermann negative.

X-ray—August, 1916, shows a bony bridging connecting the 3rd and 4th lumbar vertebræ on the left side. There is also seen the formation of bone connecting right transverse process of the 5th lumbar vertebra with the sacrum.

CASE 2.—B-7565. Age 24, Italian, laborer. Admitted, November 22, 1917; died, May 29, 1919.

Complaint—Pain in the region of the hip joint.

CASE No. 2.—B-7565. X-ray shows firm bony bridging between 2nd and 3rd lumbar vertebræ on the right side.

Family History—Negative.

Past History—Has always been well. Never had any illness to cause him to stop work until one year ago when he was injured by being crushed by a steel crane. Was in the hospital for two weeks. Habits are good. Never had any venereal diseases.

Present Illness—Began about five months ago with occasional pain in the front of the thigh, in the lower portion of the back. Intervals of pain gradually became more frequent and more severe. Stiffness of the muscles around the right hip noticed. He gradually lost his ability to bend forward and to the right. Abscess in right lumbar region was aspirated and later drained by operation. Pus was inoculated into a guinea-pig and tuberculosis found on autopsy. Wassermann negative.

X-ray—October, 1917. Bone destruction in the 2nd and 3rd lumbar vertebræ with bridging on right side.

CASE 3.—Age 44, married, laundress, colored. Admitted, March 16, 1919; discharged to Branch Hospital for Consumptives, September 4, 1919.

Complaint—Pain in the lower part of the back.

Family History—Mother living and in good health. Father died of bronchitis. Three brothers and two sisters living and well. One sister died of heart trouble.

Past History—Had operation for fibroids several months ago. Usual diseases of childhood. Has suffered with rheumatism. One year ago first noticed a bulging in the spine and has had severe pain in the abdomen for several months. The limbs gradually lost their power; has not been able to walk for about one month. Legs stiff and numb. Has been going about the house on her hands and knees. Husband has been massaging her back over the prominent vertebra. No history of cough but she has night sweats.

Present Illness—Legs are spastic, but can still move them voluntarily. Wassermann negative.

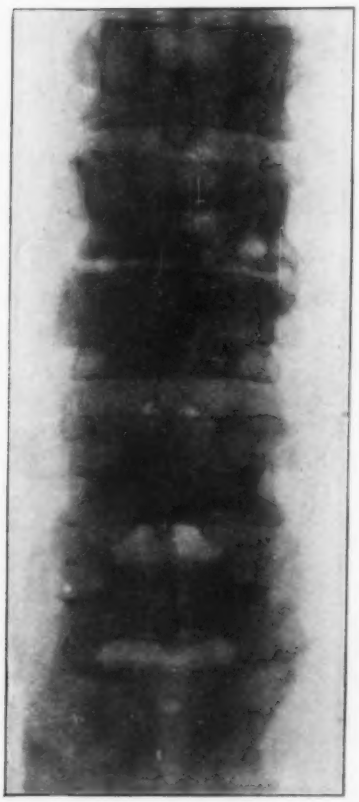
X-ray—March 18, 1919, taken of the dorso-lumbar spine shows a deposit of bone almost amounting to complete bridging on both sides of the inter-vertebral joint of the 11th and 12th dorsal vertebræ. There is also fusion in the region of the 7th and 9th dorsal vertebræ, with some bony destruction and absorption of the intervertebral disk.

CASE 4.—D-3601. Age 60, married, housewife. Admitted, June 1, 1919; died, September 11, 1919.

Complaint—Pain in the back and legs; numbness extending from the abdomen to the feet.

Family History—Mother and father dead. Mother died of asthma, one brother died at the age of fifty-seven, of asthma.

Past History—Usual diseases of childhood, rheumatism since age of fifty-two. Has had two children, one died at age of four years of brain fever, second child died when born. Denies any venereal infection. Habits good.



CASE No. 6—D-8013. X-ray taken of spine after removal at autopsy, showing destruction of the 2nd lumbar vertebra and bony bridging between 2nd and 3rd lumbar on the right side.

Present Illness—Began twenty-six weeks ago with pain in the back and legs and has gradually increased and is now unable to walk or stand. Wassermann negative.

Was operated upon by surgical service July 28th. Incision made at the level of the 10th and 11th dorsal vertebræ. Some yellowish purulent fluid was evacuated and somewhat cheesy pus appeared in the wound. Dura was exposed, the cord revealed an abnormal appearance. Cigarette drain applied and the wound was closed. Slight improvement followed laminectomy.

X-ray—Examination, June 9, 1919, showed bridging between 2nd and 3rd lumbar vertebræ. Lateral view shows no evidence of bone destruction. August 22nd, x-ray shows marked destruction of the body of the 3rd lumbar vertebra.

CASE No. 6.—D-8013. X-ray shows destruction of the body of the 2nd lumbar vertebra and inter-vertebral disk between the 2nd and 3rd lumbar. Bony bridging between the 2nd and 3rd lumbar on the anterior surface.

CASE 5.—D-3861. Age 25, single, gardener. Admitted, May 19, 1919; transferred to War Risk Service, May 29, 1919.

Complaint—Abscess in the back following a sprain two years previous, caused by heavy lifting.

Family History—Negative.

Past History—Negative. Denies venereal diseases.

Present Illness—About May 5th, 1919, began to have pain and swelling in the left lumbar region and unable to bend forward. Abscess was aspirated and pus obtained which was sterile. Guinea-pig inoculation negative. Wassermann negative.

X-ray—August 25, 1919, shows bony lipping between the bodies of the 4th and 5th lumbar vertebræ, also bony outgrowth at the right side of the body of the 4th lumbar vertebra. Lipping also between 12th dorsal and 1st lumbar.

CASE No. 6.—D-8013. X-ray taken of spine after removal at autopsy, showing destruction of the 2nd lumbar vertebra and bony bridging between 1st and 2nd lumbar vertebræ.

CASE 6.—D-8013. Age 23, laborer, colored. Admitted, December 8, 1919; died, September 30, 1920.

Complaint—Mass in the right side of the back.

Family History—Reveals no evidence of tuberculosis.

Past History—Patient had the usual diseases of childhood and has always been well until the Fall of 1918, at which time he states, he was in the hospital with a fever. Has always been regular and moderate in all his habits.

Present Illness—Began March, 1919, at which time he fell from a step-ladder, landing on his right side. Following morning began to suffer with severe pain in the right side, increased on any movement of the spine. Swelling first appeared in June, 1919. December 12, 1919, 170 c.c. of greenish-yellow pus was aspirated and sent to the

laboratory. On February 24, 1920, abscess was drained. December 13, 1919, acid fast bacillus found in pus; culture negative. Wassermann negative.

X-ray—December 12, 1919, showed marked bony destruction of the 2nd and 3rd lumbar vertebræ and thinning of intervertebral disk with bony bridging extending between 2nd and 3rd lumbar vertebræ. Findings suggested tuberculosis involving chiefly the second lumbar vertebra.

CASE 7.—E-1908. Age 23, single, clerk. Admitted, March 1, 1920; discharged, March 27, 1920, to return later.

Complaint—Pain in the back, especially on bending forward.

Present Illness—Began about January 28, 1919, while riding on a truck in Germany. Patient lay in a hay loft in a barn over three days without being able to move. Back was then strapped and he was taken to a hospital where he remained for six months.

Examination—No deformity present. Limitation of spinal movements in all directions. Wassermann negative.

X-ray—Made March 5th, 1920. shows new bone formation projecting from the edges of the body of the 5th lumbar vertebra, also slight lipping of the body of the 3rd lumbar vertebra. Between the bodies of the 1st and 2nd lumbar vertebræ on the left side there is evidence of bridging; also a rarefaction in the 5th lumbar vertebra suggesting a tuberculous condition. Patient was treated with cast and referred to War Risk Ward.

CASE 8.—E-3215. Age 46, married, laborer. Admitted, April 17, 1920; dismissed, June 6, 1920.

Complaint—Chronic lame back.

Family History—Mother and father living. Two brothers living and well.

Past History—Had pneumonia twenty-five years ago at Bellevue Hospital. Influenza, 1918 and 1919. Ordinary diseases of childhood. History of chancre when seventeen years of age. Has had gonorrhea. Has lost about forty pounds since 1918. Regained some weight.

Present Illness—Started in December, 1919. Attempted to swing on a car and felt something give way in his back. Was examined at the out-patient department and referred to Branch Hospital for Tuberculosis where he stayed until February, 1920. Is unable to stoop over or bend to either side without great pain. Is better when resting in bed. Wassermann negative.

Diagnosis—Spinal tuberculosis. Pulmonary tuberculosis.

X-ray—April 21, 1920, shows marked bony destruction of body of 2nd lumbar and lesser bone destruction of body of 1st lumbar vertebræ. There is a bridging between bodies of 1st and 2nd lumbar vertebræ, on the right side.

Roentgenologist's opinion, tuberculosis of spine.

Patient returned for body jackets. Condition improved.

CASE 9.—E-5397. Age 45, single. Admitted, July 20, 1920; discharged to Branch Hospital for Consumptives, August 10, 1920.

Patient sent into the General Hospital from the Tuberculosis Sanitarium where he has been for eight years suffering from pulmonary tuberculosis.

X-ray—Plates of the dorso-lumbar spine show a gross bone destruction of the bodies of the 10th, 11th, and 12th dorsal and 1st and 2nd lumbar vertebræ. There is bony bridging between the bodies of the 1st and 2nd lumbar vertebræ, on the right side. There is an area of increased density extending about the dorsal vertebræ laterally on either side about one inch, giving an appearance of an abscess formation.

CASE 10.—E-8076. Age 42, male, clothing cutter. Admitted, November, 1920; has not been discharged.

Complaint—Pain in the lower part of the back.

Family History—Mother living and well. Father died at age of sixty-eight, cause unknown. One sister living and well.

Past History—Has had cough for the past two years, which has decreased somewhat at the present time. Does not have night sweats. Has lost eighteen pounds in weight. Denies venereal infection. Had influenza two years ago.

Present Illness—Pain began as a dull, continuous ache in the lower part of the back in October, 1919. Began very gradually but continuously increased in severity. Coughing or sneezing increases the pain in the back. Patient has observed difficulty in putting on his shoes and socks, or when bending over to pick up anything from the floor. At night when asleep he is often awakened suddenly by severe pain in the back.

Examination—Patient moves very carefully, sitting down or getting up very cautiously. There is limitation in all movements of the lumbar spine. Muscles are tense. The 4th lumbar vertebra shows a prominence, but there is no tenderness on pressure. Wassermann negative.

X-ray—Taken January 25, 1921, shows destruction of the 4th and 5th lumbar vertebræ with bridging connecting the left sides of the bodies of the 4th and 5th lumbar vertebræ.

REFERENCES.

1. ELY, LEONARD W.: Diseases of the Bones and Joints, 1914, p. 59.
2. FRASER, JOHN: Tuberculosis of the Bones and Joints, 1914, p. 114.
3. CAMPBELL, WILLIS C.: Jour. A. M. A., Aug. 19, 1916, p. 572.
4. TUBBY, A. H.: The. Deformities, Including Diseases of the Bones and Joints, 1912, Vol. 2, p. 198.

EARLY SYMPTOMS OF SPINAL CANCER.

BY EDGAR D. OPPENHEIMER, M.D., NEW YORK.

CARCINOMA of the spine, that is, of the bodies of the vertebræ, is not a very unusual condition. Indeed the spongy bones, particularly the bodies of the vertebræ, are probably the most favored sites for the location of metastases. With increased facilities for autopsies and more thorough examination of the skeleton in patients having died of carcinoma, the pathologist has come to recognize this connection as a matter of course.

The clinician, however, not so favored, still fails to appreciate this coincidence and frequently fails to recognize metastatic carcinoma of the spine and other bones until he has had to undergo the mortification of an incorrect diagnosis and prognosis. Such failures are not, however, always due to superficial examination. It is true, of course, that those who, like orthopædic surgeons, are insistently concerned with anomalies, infections, tuberculosis, and syphilis of the spine, are apt to bear these in mind more or less to the exclusion of much more unusual pathological processes. The mistaken diagnosis cannot, however, be wholly attributed to this cause. For though in well advanced cases with evident primary foci the diagnosis is obvious, the correct interpretation of the symptoms in the early stages is often fraught with difficulty, even with suspicions aroused and in spite of the most painstaking examination.

The difficulty is due to the fact that all pathological conditions—and this applies particularly to carcinoma—cause no definite objective symptoms as long as they remain confined within the substance of the bones. In tuberculosis and other infections it is true the focus soon leads to an inflammatory reaction on or near the surface, and this is usually manifested by muscular spasm, and as a consequence spinal rigidity. But spinal rigidity occasionally accompanies malignant disease of the spine, and there are cases in which pain and restricted motion of the spine are the only symptoms over a period of months. When a primary focus cannot be discovered, and the radiograph is negative or doubtful (not a very usual happening in such cases), the differential diagnosis will sometimes try the skill of the most expert.

Even at a later stage, when there are definite signs of bone destruction, the character of the change in the conformation of the spine is not always decisive, as is generally supposed. A well-rounded kyphosis that extends over a number of vertebræ, accompanied by rather

slight and ill-defined pain, may appear in Pott's disease; on the other hand, an acute angular kyphosis is occasionally the earliest manifestation of carcinoma. We have seen cases in which it was, in the absence of a primary focus and other symptoms, very difficult, or quite impossible, to differentiate these conditions even with the aid of an expert radiographer. This, of course, is a very unusual coincidence.

Symptoms of root invasion, in the absence of the bony changes of tuberculosis or other infections, are for the most part characteristic of carcinoma. They are not, however, absolutely pathognomonic, for these symptoms sometimes present themselves as early manifestations of tumors or other diseases of the spinal meninges. The appearance of the segmental symptoms of spinal compression soon leads to the differentiation of meningeal tumor, etc., from carcinomatosis; in one case under observation the segmental symptoms of a tumor of the meninges were late in appearing and the diagnosis remained in doubt for a period of two months.

It is needless to enter into a detailed discussion of all the difficulties that may be encountered in the differentiation of spinal cancer. What has been said suffices to bring out the fact that even in the late stages, when the symptoms are usually quite definite and generally appreciated, we may occasionally be unable to make a proper diagnosis, and this in spite of the most painstaking and expert examination.

This being true, it is not surprising that cancer of the spine is often entirely unsuspected during the early stages. At this period there is little danger of mistaking the condition for mycotic or tuberculous spondylitis or other organic lesions, but there is, not a possibility, but a great probability, that the condition be misinterpreted as functional. Vague back pains, ill-defined pain on pressure over the spine or the sacro-iliac, and negative x-ray report, too readily tempt one to consider the condition functional. No doubt many of us remember such cases.

With this circumstance in mind, I decided to examine critically the rather numerous cases of carcinomatosis that have come under my notice in the Montefiore Home and elsewhere, in an attempt to discover a train of objective symptoms so characteristic that one could make the diagnosis of cancer of the spine earlier and more definitely.

Pathological processes within the vertebræ apparently cause no symptoms as long as they remain within the interior of the bone. Symptoms appear,—(a) when the process begins to emerge from within and invade the extramedullary tissues, or, (b) when the bodies of the

vertebræ have been undermined, and give way, and the spine undergoes changes in contour.

The methods of differentiating cancer from other lesions of the spine must therefore be founded upon,—(a) a characteristic manner of invading the surrounding tissues, *i. e.*, the spinal cord or roots and, (b) characteristic changes in the contour of the spine.

The symptoms of actual invasion of the spine or the spinal roots are of course striking; the continuous indescribable agony that attends the carcinomatosis of the spine is fortunately characteristic of no other pathological process. Before extensive root irritation has occurred the symptoms and objective findings are not so definite and, in the absence of a demonstrable primary focus, are often difficult to interpret. According to the leading authorities, marked continuous neuralgic pains, especially bilateral or segmental in character, not influenced by the usual therapeutic remedies, should lead one to suspect cancer. In connection with other signs and symptoms, however, they are often of service in making the diagnosis; thus, continuous bilateral sciatica often leads to the search for and the discovery of a heretofore unsuspected primary cancer. It should lead to a search for cancer in situations where primary carcinoma is sometimes overlooked, unsuspected or difficult to demonstrate; *viz.*, the lungs, thyroid, and prostate. When, however, the cancer cannot be demonstrated elsewhere, then the root symptoms, as the following case history illustrates, are difficult to interpret.

A. B. Aged 52. Previous history: For the past six months has been complaining of pain in the hypogastrium, which has gradually increased in severity until now it is difficult to relieve, and then only temporarily by morphine. He was in the care of a gastroenterologist for some months and was treated for gastric or duodenal ulcer. As he was not relieved he sought advice from a number of others and the removal of the appendix was advocated. Examination shows a fairly well nourished individual; complains of pain in the pit of the stomach, which is continuous, and not relieved by heat or change of position, and only partially by opiates. Abdomen flaccid with no signs of abnormality of the contained organs. Suggestion prompts him to describe the pain as radiating from the spine forward. Medical, physical, Wassermann, etc., negative. Spine rigid but without local tenderness; x-ray shows no definite abnormality in the spine, other bones not taken. The rigidity of the spine and the pain radiating to the hypogastrium suggested a spondylitis, and cancer was not suspected. For this reason the spine was immobilized in a plaster of Paris jacket. Instead of the expected relief, the pain increased to such an extent that after a few

days the jacket was removed. Subsequently he suffered spontaneous fracture of the ribs and developed the symptom complex of general carcinomatosis.

This case, which resembles a number of others which have come under observation, is instructive in a number of ways. It illustrates not only the difficulties in the way of diagnosis, but it suggests some differentiating factors; thus for us, continuous pain more or less segmental in character, indefinite or negative x-ray findings with spinal rigidity, particularly when the condition is exaggerated by immobilization, always leads to a search for a primary carcinoma and, even when this is absent, strongly suggests malignant disease. We have not been able to discover why immobilization increases the pain in these cases (it is likely that it prevents the patient from assuming an attitude that somewhat alleviates the suffering), but in a number of cases this aggravation of the symptoms has occurred and we now consider this coincidence as definitely suggestive of carcinomatosis.

We have concluded, from an examination of the cases, that the early signs of root involvement from carcinoma have the following clinical manifestations. The symptoms are those of sensory root irritation as distinguished from a peripheral nerve lesion. What is usually designated as a bilateral sciatica is not a sciatica, but the pain and its distribution will, on careful examination, be found to correspond to one or more roots of the sacral plexus. When the spine higher up is involved, the symptoms are clearly segmental in character; usually other sensations are intact and the motor sphere is only involved late in the disease. The pain is always greatly exaggerated by immobilization; is more or less continuous; it prevents but does not interrupt sleep as does the pain in spondylitis. These symptoms appear with or without spinal rigidity and are not infrequently present when the radiograph of the spine is negative. They are in themselves not characteristic but should always arouse suspicion and encourage the search for primary carcinoma, and, in conjunction with other suspicious signs, often secure the diagnosis.

In many of the individuals seen early, that is, before the disease has reached the extension of the vertebræ, the subjective symptoms are vague. The patient complains of pain in the back, over the sacrum or the sacroiliac joint, and frequently is unable definitely to localize it. In such cases we have tried to discover the earliest changes in the spine. That is, we have searched for the objective changes that precede the characteristic x-ray findings and the actual gross deformation of the spine of extensive cancer invasion.

Until recently our histories show that we had not demonstrated these

changes. This was due to the fact that we made no careful search for them or, as it is true of the root symptoms in many of our earlier cases, we did not properly interpret or lay sufficient stress upon them. Since we have studied the subject more intensively we have found that it is often possible to foretell the ultimate vertebra breakdown long before it actually occurs and not so rarely before the radiograph gives positive results.

Of these changes, most typical is slight dislocation forward, so that there appears a more or less definite recession of particularly one or a few spinous processes as they are successively palpated from above downward. In some of the more marked cases the palpating finger suddenly meets with a sharp depression as it reaches the subluxated vertebra.

In another group of cases we have been able to discover the presence of slight later displacements which only months afterward became pronounced. This change is due to carcinomatous invasion of the lateral processes and the ligaments of the lateral joints of the spine. In two cases we have found slight lateral displacement the only symptom except vague back pains. In the absence of demonstrable primary carcinoma, the diagnosis in these cases remained in doubt for some months, and was not definitely confirmed until symptoms of general carcinomatosis appeared. In two others, marked lateral dislocation and other changes soon followed the discovery of the slight displacement.

In another group of cases we have been able to demonstrate the compression of the bodies of individual vertebræ as it occurs very early in the disease and before it is apparent in the radiograph, by what we think is a change in the relation between the adjacent spinous processes of the affected vertebræ. Rarely, the only change is a shortening of the distance between the adjacent spinous processes; more often the change in the height of the vertebræ is complicated by a variable amount of torsion.

These changes in the contour are, of course, not absolute criteria in the absence of other symptoms. They are, however, very suggestive in connection with other symptoms not in themselves definite. In practically all the cases that we have been able to follow up, the diagnosis was substantiated. And though we are far from assuming that these slight objective differences in the contour of the spine are pathognomonic of cancer, we feel that slight lateral displacements, discrepancies in the relation between adjoining spinous processes, with or without lateral deviation or torsion, are very significant symptoms.

At least they should lead one to suspect cancer, and therefore strongly stimulate the most thorough search for other evidence of carcinomatosis.

With the facilities for thorough search for primary cancer and the expert radiography at our command in all general hospitals, why, it may be asked, is it necessary to seek new clinical data, or magnify the significance of the changes we have here described? But it has been our experience that if we except the more common carcinomata the primary focus is not always easy to demonstrate. Indeed, in some of our cases the primary carcinoma in the prostate, thyroid or lungs had not been demonstrated in patients with general carcinomatosis until they came to autopsy. Nor does the radiograph always clear up the diagnosis in the early stages. We have seen cases in which the radiograph was apparently negative three or four weeks before the characteristic deformation and symptoms of advanced carcinomatosis supervened. Of course the advanced cases show characteristic changes with which all are familiar. The early pictures are, however, often negative, or cannot be definitely interpreted without additional clinical data. We have carefully re-examined a great number of the plates taken at the Montefiore Hospital, where there is a large cancer service, without being able to find definite and characteristic findings for the earliest stages. Slight changes in the outline of bodies, sometimes shown only in the oblique pictures, are the usual first signs. The only additional assistance we have derived from this source was obtained by radiographs of the other bones when the plates of the spine were negative, because we can, for technical reasons, demonstrate more easily the lesion in the femur, humerus or skull. In this we have been able to confirm the observations of others that at times cancer of the femora or other bones could be demonstrated when the symptoms apparently originated in the spine, but the plates of this region were negative. The characteristic small, well-defined shadows due to multilocular growths are striking, but occur late, and the early x-ray diagnosis must usually rest on a careful study of all ill-defined shadows so often described as "picture unsatisfactory." These lesions are rapid in growth and the comparison of weekly radiographs will show an increase of a suspected lesion and allow us to state that real atrophy exists, not comparative atrophy.

On the whole, then, according to my investigation, the early diagnosis of cancer must be in many cases tentative. It can be verified by the search and demonstration of primary foci elsewhere. In conjunction with other symptoms, in themselves not decisive, the peculiar character

of the root or segmental symptoms, or the early changes in the conformation of the spine here described, will often greatly aid in securing the diagnosis.

I herewith append an abstract and an analysis of the history of thirty-two cases of cancer of the spine under observation at the Montefiore Hospital on whom satisfactory data were obtainable. I am indebted to Dr. I. Levine who has charge of the Cancer Service for permitting me to use his cases.

The site of the primary lesion was found to be in the breast eighteen times, lung four, prostate five, thyroid three, kidney one, pancreas one, in a total of thirty-two carcinomata. The metastatic symptoms appeared before the primary focus could be determined in twelve cases. Three cases in addition, presenting spinal symptoms, had breast operations eight years previous without recurrence, and the symptoms of the metastases took that length of time to become evident. The primary lesion was not found at all clinically in six cases and proved at autopsy to be in the breast one, thyroid two, lung one, prostate two. Pathological fractures were present before the diagnosis of carcinoma was established in the spine four times, femur three, humerus two, elsewhere two. The first symptoms in seven cases, in which there had been no local pains, were fractures following slight trauma. Local spinal symptoms were present in twenty cases early in the history; ten showed pain on local pressure, and fourteen deformity. In no case was there tumor present on the spine, and sacral tumors in three cases appeared only late in the disease. Spinal pains were complained of in nineteen cases and were an early symptom in nine cases. In fifteen cases the lower extremities were the seat of pain and in thirteen cases this was an early symptom. Symptoms of metastases, other than spinal, were present in sixteen cases and early in thirteen cases. Sensation of cold was complained of in thirteen cases, and herpes zoster was found in two cases. We found positive spinal x-rays in fifteen cases and in eight they were negative. Of the eight negative cases, three showed lesions in other bones. The cases with early cord and root symptoms, as a rule, gave negative pictures at the time of onset and some even at the end. Our cases presenting metastatic bone and cord symptoms gave an average duration of fourteen months. The duration of nerve symptoms in seventeen cases averaged ten months, and fifteen cases had no symptoms referable to the central nervous system.

CASE 1.—01207. E. H., female, aged 60 years. Admitted April 9, 1917; died April 13, 1917. October, 1915, had pain in right foot

and knee grew gradually worse and was bedridden all winter. April, 1916, was seven weeks at C. N. Hospital for constant pain in lower portion of spine and weakness of both lower limbs. X-ray diagnosis—Pott's disease. Six weeks in plaster corset; after removal of corset developed hematuria. October, 1916, was sent to Mount Sinai Hospital where hematuria was controlled and examination showed round diffuse kyphos in upper dorsal region with immobility but no acute spasm. Vertebræ not sensitive. Paralysis of lower extremities. X-ray showed almost complete destruction of second and third lumbar and changes in the 1st, 4th, and 5th lumbar vertebræ. Diagnosis, T. B. C. or malignant. On admission to Home—for last six months increased frequency of urination—for one month complete transverse myelitis. X-ray—large neoplasm entire lumbar spine, metastases in dorsal spine, femora, ribs, signs of arthritis deformans. Autopsy—Carcinoma breast, metastases in spine 7 to 11 D, 2 to 5 L, skull, bones, liver, glands.

CASE 2.—PP 14. H. McM., age 79 years. Admitted, May 30, 1917; died September 11, 1917. For several months indefinite pains in back, sticking in character and fairly constant, not influenced by treatment or medication. X-rays,—kidneys negative, spine moderate arthritic changes. Spinal brace for arthritis made pains worse. Unable to wear brace. On admission severe pains in back and shoulders, pains in legs, and weakness. X-ray in July, 1917, showed aneurysm in arch of the aorta, heart enlarged, lungs negative, no bone changes. The paralysis of legs gradually increased, followed by a transient Brown-Séquard crossed paralysis, and on September 5th complete paraplegia below the waist and a gradual kyphos at dorso-lumbar region. Prostate enlarged with hard nodules. Diagnosis: carcinoma of prostate, metastases of spine and cord.

CASE 3.—02150. H. H., male, age 48 years. Admitted, March 12, 1919; died April 12, 1919. September 10, 1918, on jumping from a street car had severe pain in heel and toes of right foot. A week later was told he had a fracture. Massage and baking ordered but discontinued on account of excessive pain. In plaster of Paris for five weeks. Removal of plaster aggravated the pain. Then pills and five intravenous because blood was positive. January 20, 1919, amputation of leg was made; since that time noticed swelling at groin and at finger. On admission, has a sacro-iliac tumor, apparently osseous. March 23d, cerebral thrombosis, facial palsy followed by partial recovery. Autopsy—primary carcinoma lungs, metastases of bones, sacrum, skull, hands, liver, adrenal, lymph glands, dura, scoliosis.

CASE 4.—0943. Male, age 62. Admitted, April 11, 1916; died, September 7, 1916. For seven months had chills, weakness, dyspnoea, loss of weight. On admission:—expectoration, pain in chest, lung signs. July 21, 1916, painful nodule on clavicle, later pathological fracture. X-ray:—April 24, 1916—cavities and fluid in lungs. July

25, 1916,—pathological fracture of clavicle. Autopsy:—carcinoma of lung with extension of mediastinum, involving 4th and 5th dorsal vertebræ. Collapse of bodies and extension into outer layer of dura.

Case 5.—0841. Male, age 52 years. Admitted, December 16, 1915; died May 6, 1916. Two years ago had cutting pain in left lower extremity from pelvis radiating down the inner side to ankle, and six months later similar pains in right limb. Plaster jacket for six months did not relieve the pain. Pain not constant and not definitely located; most of the pain in legs down to ankles. No pain in feet and could not walk or sit. Turning in bed gave sharp pain in back of pelvis; only when on either side did he find comfort. On admission—complains of pain in pelvis and both lower extremities; consequent inability to walk any distance. Thyroid negative, neurological negative; spine not tender; no deformity or rigidity. Pains considered functional. January 25, 1916—pains vague and irregular, at times severe and frequently absent. On rotation intense sacral pains; prostate somewhat hard and enlarged. X-ray—slight defect in the outline of the body of the 4th lumbar vertebra not clear. April 16, 1916—very severe pain in both hips; motion left lower limb limited and very painful; knee jerks absent. X-ray, April 20, 1916—defect in 4th lumbar, also 3rd and 5th. Retention of urine and feces developed, also loss of weight. Spine shows no deformity or tumor but has extreme tenderness on pressure over 3d, 4th, and 5th lumbar spine and both sacro-iliac joints. Later followed symptoms of cord involvement. Autopsy:—malignant adenoma thyroid with metastases to lumbar vertebræ. Body of 4th lumbar replaced by fleshy tumor mass penetrating through disc to 3rd and 5th lumbar, tumor encroaching on canal though it does not project through the meninges. Hemorrhage of lumbar nerve root.

Case 6.—01129. F. G. Male, age 63 years. Admitted, August 24, 1916; died, February 9, 1917. Since January, 1916, had pains in left thigh which were constant, but at times so severe that he could not walk. On admission,—lumbar and sacral spine painful on pressure, more marked on left side. Muscular rigidity but no tumor present. Deep and superficial tenderness of left lower extremity; rectal negative. X-ray, August 31, 1916, general carcinomatosis lumbar spine, sacrum and left femur. Autopsy:—carcinoma of prostate, metastases in bones, femur friable, replaced by tumor.

Case 7.—0591. B. F. Female, age 56 years. Admitted, July 6, 1915: died, July 25, 1915. One and one-half years ago patient fell and was unable to raise herself. Was put in plaster corset for five months. Since March, 1915, was unable to walk. On admission,—marked tenderness dorso-lumbar spine; entire spine rigid; marked lateral curvature at 2nd lumbar. Entire left lung dull. Autopsy:—primary adeno-carcinoma lung, metastases in pleural, liver, adrenal, ribs, vertebræ, glands, suppurative pericarditis, duodenal ulcer, slight compression of cord equina by metastasis at 2nd lumbar.

CASE 8.—01782. B. K. Male, age 40 years. Admitted, June 9, 1918; died, September 9, 1918. July, 1917, cutting, cramplike pain in left inguinal region, radiating to testicle, so severe that patient was unable to walk. Ten months ago pain in left lumbar region, then pain in left axilla, radiating to spine. Pain constant, made worse without cause; no relief from medication or therapeutic treatments. Tenderness over left chest; herpes zoster along course of intercostal nerve. Teeth extracted, February, 1918. Gave streptococcus viridans in pure culture as did the tonsil. Wassermann negative, spinal fluid negative. X-rays, February 25, 1918,—sinuses, cloudiness of both anterior ethmoids. X-ray of spine unsatisfactory. Considered a pernicious neurotic. For past two weeks pains in right hip, increased by motion. Small swellings over ribs anteriorly and behind ears. On admission,—pains in back, shoulders, hip, stiffness of neck; masses over chest and hip painful on pressure. Loss of weight, fifty pounds in year. Small, hard mass in front of neck, not painful. On examination, patient very sensitive; flexion left thigh causes severe pain, as does any motion. No tenderness of vertebræ or femur. Feeling of cold in right lower extremity. June 28, 1918, prostate negative. Very hard tumor size of nut adherent to fascia and laryngeal cartilage; not painful. X-ray, June 18, 1918,—small diffuse spots throughout bodies of vertebræ and 12th rib. Multiple fractures of ribs. Irregular bone destruction along S. I. joints, pelvis, and left femur. Infiltration of lungs with carcinoma of thyroid. Metastases of bones and lungs.

CASE 9.—0734. F. E. Female, age 56 years. Admitted, November 10, 1914; died, January 1, 1916. Onset, 1911, with pains in thighs. Breast amputated, September, 1913. After one year, recurrent, followed by marked weakness; no muscle atrophy. Could not raise heel off bed. Neurological examination negative. December 24, 1915, fell off a chair, fracturing lower one-third of femur. X-ray showed carcinoma. Autopsy:—ribs, femur, spine showed carcinoma.

CASE 10. 0753. Female, age 45. Admitted, October 1, 1915; died, January 22, 1916. One year ago had pain in left arm, and breast was removed. Then developed pains elsewhere; these grew worse and the patient weaker. On admission,—atrophy, small muscles right hand; painful spots on spine; swelling on lumbar region; bed sore; increased reflexes; later, signs of cord compression. X-ray, October 14, 1915,—metastases show in all bones, best in hips, shoulders, ribs and skull.

CASE 11.—03041. B. B. Female, age 69. Admitted, July 30, 1918; died, November 19, 1920. Five years ago bloody expectoration, ill four weeks. Well for two years, then pain in right foot and leg. Pain beginning in hips and radiating downwards, then pain in both legs, edema of legs. Stiffening and weakness of right hand. Diagnosis:—Mitral regurgitation, arteriosclerosis, chronic arthritis, facial palsy,

October 14, 1920, recurrent carcinoma right breast, ulcerations on cuirasse. X-ray:—Marked hypertrophic anthritis of spine, metastases not evident.

CASE 12.—0761. R. R. Female, age 43. Admitted, January 1, 1916; died, February 3, 1916. May, 1915, noticed tumor in breast. Operated in August. Then followed pains in thighs, later in spine, also of piercing character. Pain on pressure along spinal processes. Kyphos evident and thickened trochanters. X-ray, January 20, 1916,—worm-eaten appearance 11 and 12 D and lumbar vertebræ, also femora. Autopsy:—Dorso-lumbar vertebræ crumble under saw, no definite metastases seen, body of 12th dorsal almost gone, metastases in liver and glands; brain and spinal cord negative.

CASE 13.—02817. H. M. Female, age 43. Admitted, December 9, 1919; died, June 13, 1920. July, 1918, operation right breast. June, 1919, stabbing, right thigh medially, when walking gradually became worse. Last three weeks pain steady in knee and in right hip. Sleeplessness due to pain; five weeks internal strabismus left eye. On admission:—two bony nodules in left parietal region, are not tender. Tenderness of right thigh, cannot lift knee off bed although motions are free. Reflexes normal, no spinal tenderness or deformity. X-ray, December 20, 1919, metastases, skull and right femur, slight erosion at fourth lumbar vertebra. April 11, 1920, irregular bone destruction throughout body of fourth lumbar and both femora where there is periosteal reaction in some places.

CASE 14.—02758. I. K. Female, age 36. Admitted, January 8, 1920; died, May 8, 1920. Four years had mass at suprasternal notch and right supraclavicular fossa which never troubled her. Ten months had mass in right parietal region, never painful. Five months ago stumbled while walking and had severe pains but managed to walk for a month. For increased pain, went to hospital, where cast was applied for fractured femur. On admission:—hard thyroid mass, soft mass at third and fourth rib anteriorly and at parietal, not tender; in plaster cast. January 23, 1920, paralysis of left leg with increased K. J., ankle clonus and Babinsky both sides. February 17, cast removed, decubitus present and signs of complete transverse myelitis. X-ray, January 13, dorso-lumbar spine negative; January 29, extensive bony destruction upper right femur, skull, lower lumbar spine. Carcinoma thyroid, metastases skull, femur, ribs, lumbar spine.

CASE 15.—02873. J. D. Female, age 26. Admitted, January 14, 1920; left, July 28, 1920; died, December, 1920. Five years ago operated, left breast; five months ago pain left hip which interferes with walking. Later, pain in hip less, but pain in lower end of spine; when in bed, pains less. On admission:—complaining bitterly of pain in left thigh with weakness that is progressively worse. X-ray, January

2, diffuse metastatic involvement in pelvis, lumbar spine, skull, lungs; collapse second lumbar vertebra. April 11, large area of bone destruction on upper part of right sacro-iliac and both pubic bones; hips negative. July 8, 1920, no complaints; pain on pressure fourth and fifth lumbar and ribs.

CASE 16:—02811. S. R. Male, age 60. Admitted, January 3, 1917; died, June 11, 1920. March, 1915, total excision of bladder for carcinoma. Later, general weakness and lung signs, no spinal symptoms. X-ray, February, 1920, pelvis negative, marked lung shadows, slight metastatic changes of the fifth lumbar vertebra.

CASE 17.—02518. Female, age 54. Admitted, May 1, 1919; died, November 24, 1919. May, 1918, noticed lump in breast, marked loss of weight, for three months pain in left eye led to its destruction. On admission:—cancer, right breast, with axillary glands; right upper extremity edematous; August 14, right eye also involved. X-ray, May 13, second lumbar vertebra somewhat collapsed and small area of bone destruction in lumbar spine, sacrum and skull.

CASE 18.—02568. R. R. Female, age 50. Admitted, August 22, 1919; died, January 8, 1920. November, 1917, breast removed; April, 1919, for pain in leg went to hospital, while there spontaneous fracture humerus. On admission:—tumor left clavicle; no glandular involvement; fracture humerus; lower dorsal spine shows sharp kyphos. left gluteal bed sore, neurological examination negative. October 29, 1919, patient rather apathetic and complains of cramps. January 2, 1920, no complaints but weaker. X-ray, November 6, 1919, moderate diffuse bony destruction spine, sacrum, pelvis, femora, scapula, humerus and other bones.

CASE 19.—0X. A. F. Female, age 40. Admitted, October 12, 1920; died, January 1, 1921. Nine years ago breast operated on, one year ago recurrence, operated; for three weeks weakness of legs, unable to walk; swelling of legs. On admission,—carcinoma on cuirasse; reflexes normal, edema left hip, spine shows marked tenderness of 7 dorsal. X-ray:—spine, pelvis, hips, shoulders negative for metastases.

CASE 20.—0X. M. M. Female, age 54. Admitted, December 9, 1920; died, December 10, 1920. Eight years ago lump in breast; operated on April, 1919; well one year, then pain in chest; grew weaker and worse. Five months ago pain more severe; increased weakness and incontinence; one month cannot stand; now transverse myelitis with bed sores and complete paralysis below hips.

CASE 21.—02924. B. K. Male, age 56. Admitted, July 29, 1920; died, September 4, 1920. Eighteen months ago influenza; cough persistent and became more constant. Four months drawing pain right

arm and pain right chest anteriorly. August 18, 1920, pain left gluteal region, pain and marked tenderness left sacro-iliac. No symptoms of spine. X-ray, August 4, 1920, beginning bone rarefaction left sacro-iliac and right humerus. Other bones negative. Autopsy:—primary tumor right lung, metastases left lung, ribs, lower spine, direct extension of tumor into superior vena cava.

CASE 22.—02251. J. D. Female, age 56. Admitted, May 22, 1919; died, June 21, 1919. Nine years ago amputation of left breast; one year ago pain across back; absent when lying down; on standing, pain down thighs and calves. March 6, 1919, tenderness over mid-lumbar, sacrum, and sacro-iliac joints. Diminished power in wasting right thigh. K. J. absent, no tenderness on stretching sciatic. X-ray showed extensive involvement of lumbar and sacral vertebræ. On admission: —inability to walk, pain in back, radiating down both lower extremities. Incontinence, edema lower extremities; slight scoliosis, abdominal negative; axillary glands palpable; mass above sacrum; vertebræ not tender to pressure; sacrum sensitive, paraplegia dolorosa. X-ray, June 18, 1919, pelvis marked rarefaction and destruction throughout entire pelvis, process most marked in the spine. Marked bilateral hilus shadows in the lungs.

CASE 23.—02256. R. B. Female, age 40. Admitted, March 27, 1919; died, June 23, 1919. Ten months ago amputation right breast; three weeks thereafter sudden sharp pain in back of neck, next pain in right shoulder, then in right thigh, so severe patient could not walk. Pain progressed to entire back, abdomen and into left thigh; later, chest and entire body became affected. On admission:—pain all over body, sleeplessness, constipation. On deep palpation back of neck, abdomen, chest painful; axilla free of glands. X-ray, April 18, 1919, marked evidence of small areas of bone destruction throughout bony system, greatest amount in bodies of 10, 11, 12 dorsal.

CASE 24.—01293. Y. D. Female, age 42. Admitted, January 7, 1918; discharged July 8, 1918. April 16, 1916, noticed lump in breast which was operated on in June; then pain in right leg. X-ray showed carcinoma. Pains in right hip and right shoulder; active motion lost due to pain. Right leg one and one-half inches short. February 27, 1917, pathological fracture humerus. Tenderness left of lumbar spine. X-ray, right shoulder, absorption of bone; right hip, fracture at neck; much destruction.

CASE 25.—01291. R. W. Female, age 40. Admitted, June 14, 1917; discharged, July 7, 1917. Two years ago lump in left axilla noticed. Breast operated on one month later; second operation, January 12, 1917. On admission:—pain all over body, especially in both humeri, left knee and back. Local recurrence at breast; both upper extremities edematous. Abdominal negative; shoulders, hips, and spinous processes all painful on pressure; no deformity, slight limitation flexion

right hip. X-ray,—spine and shoulders negative; hips, left slight destruction below acetabulum,—right, slight arthritic changes.

CASE 26.—01418. M. R. Female, age 48. Admitted, October 22, 1917; died, October 27, 1917. September, 1915, vomiting attacks. Operated for tumor of left kidney; five months ago sitting in chair, was unable to get up, had pain in dorso-lumbar region. On being helped up was unable to straighten back; four weeks later feet began to swell; could not move feet; sleeplessness from pain in back; last ten weeks lost control of bladder, then, also bowels. On admission:—right buttock ulcer, paraplegia, cystitis, metastatic carcinoma dorsal and lumbar spine from left kidney.

CASE 27.—02324. R. S. Female, age 35. Admitted, June 17, 1919; died, July 28, 1919. Nine months ago severe pain in region of stomach, and headache. Constant pain radiating down sides of legs. Examination shows palpable mass attached to liver; spinal column very tender to touch at 8th dorsal and below. June 20, complains bitterly of pains in back; June 26, incontinence, pain all over body. Autopsy:—carcinoma pancreas, liver, and stomach, involving spinal column.

CASE 28.—C2. S. T. Female, age 40. Admitted, June 17, 1920. Four and one-half months ago while stooping found that she could not lift her lower extremity and the next day her right. Difficult walking, weak; later, stabbing pain and burning over entire back; continuous sticking pain in lower part of right chest. May 12, 1920, operation, breast, for inoperable carcinoma. Angulation to left at 3rd and 4th dorsal. On admission:—weakness, arms and legs, reflexes increased. June 25, 1920, local pain in first and second lumbar; no sensory changes. January 16, 1921, no pains now in back; spine somewhat sensitive; gradual kyphos. X-ray, June 21, 1920, rarefaction of bones of spine, rather indefinite.

CASE 29.— C2. S. L. Female, age 42. Admitted, September 22, 1920. Breast operation two years ago; four months ago feeling of cold all over body; three months ago edema of left arm, weakness, left facial palsy, left knee swollen and tender. On admission:—local recurrence, left knee swollen and tender. X-ray, October 4, 1920, left tibia, fibula, femur show a few spots of rarefaction. Moderate irregular rarefaction throughout upper sacrum.

CASE 30.—C3. J. S. Male, age 57. Admitted, April 21, 1920. December 29, 1919, suprapubic operation for bladder stone. Adenoma with carcinomatous changes, also carcinoma prostate. June 19, pain left loin downward to thigh,—urinary disturbance. On admission:—weakness, especially legs, constipated, pain side of thigh, inoperable prostate carcinoma. July 7, 1920, pain left femur, local tenderness. January 17, 1921, spine tender at places, but can walk. X-ray, July

15, 1920, cervical spine negative. August 10, 1920, small areas destruction third cervical. Extensive diffuse rarefaction upper part of femur.

CASE 31.—W1. S. G. Male, age 88. Admitted, July 23, 1920. About six months ago weakness of both legs, progressive until unable to stand, followed in one month by inability to urinate. Three months ago prostatectomy for enlarged prostate. On admission:—inability to stand or walk, no bladder or rectal disturbance, no pain, paraesthesia or swelling of extremities. Later, there developed signs of local cord lesion with a zone of hyperæsthesia across chest and paræsthesia of left lower extremity more than right. Distinct depression at height of tenth dorsal vertebra, slight sensitiveness over entire spine. Hard nodule region of prostate now felt. X-ray:—Arthritis of second and third lumbar, otherwise negative.

CASE 32.—E2. E. O'G. Female, age 27. Admitted, October 4, 1920. September, 1918, breast amputation. October, 1919, to hospital for back complaints, pain and weakness in lumbar region. Spinal corset gave no relief. Several x-rays were negative; January, 1920, at another hospital, x-rays diagnostic. Radium treatments given. June and July, well again. On admission:—complaint for sixteen months of stiffness in back and pains in back radiating down thighs. Cannot walk, but can stand. X-rays show very marked bone destruction of pelvis and spine. January, 1921, free from pain and has no tenderness on local pressure of spine and pelvis; sensorium intact; distinct depression fifth dorsal vertebra and kyphos upper dorsal. Increased reflexes and spasticity of legs; marked loss of weight, signs of cord compression.

A STUDY OF 208 CASES OF LOWER BACK PAIN.

BY J. R. KUTH, M.D., DULUTH, MINNESOTA.

COMPLAINT of pain in some area of the lower back is a very common one in many conditions. In many cases it is the sole complaint, is chronic, and the etiology is more or less obscure. After thorough physical examination the objective findings are so meagre and indefinite that one is unable to point to a definite area or to a definite lesion and say the symptoms are due to such an injury or to such a disease located in this or that tissue. These patients form a large class commonly seen in private practice and in the practice of the various specialties. The chronicity of these cases and the eagerness with which these patients seek relief indicate the seriousness of the condition and the difficulty of its successful treatment.

The present study concerns itself with 208 cases of low back pain. It does not include cases of obvious or manifest disease or injury of the lower back structure such as tuberculous, typhoid or syphilitic disease of the spine; gross traumatic lesions of the spine or cord or lesions of the cord itself. During the period in which these cases were observed, many women with low back pain were examined and followed for a time. These rightfully belong in this series but are not included because of insufficient data.

There were in the series 136 males and 72 females. The average age of the patients was 37 years (the youngest was 12 and the oldest 70). In 180 cases, previous attacks during the preceding years were admitted by 80, and denied by 100. In 75 cases, possible trauma was given as a cause for the trouble, in 77 there was no knowledge of any injury. In 6, the trouble preceded or followed childbirth.

In 182 individuals, in which the general build and their physical characteristics were noted, 93 were classed as tall or short but strong and muscular, 55 as very fleshy or overweight, 7 as small and thin but strong, 27 were noted as tall, thin, and weakly. Ninety-nine males followed so-called arduous occupations (farmers, factory and ordinary laborers, miners, dock and railroad laborers), 37 were classed as clerks or professional. Of the 72 females, 56 were housewives and the remainder followed the more or less exerting occupations of women.

Pain in the lower half of the back was the chief complaint in all cases. It was localized by the patient either in the middle, or to one or both sides. The most frequent site (see Figs. 1 and 2) was the sacro-iliac area (97 times). Next in frequency were: the lumbar area (55 times), lumbo-sacral area (31 times), gluteal area (19 times), dorso-

AREA	GROUP	R	L	R & L	MID	TOTAL	
Dorsal	I	0	0	0	2	2	2
	II	0	0	0	0	0	
Dorso-lumbar	I	0	0	0	6	6	11
	II	0	0	0	5	5	
Lumbar	I	2	2	20	0	24	55
	II	7	8	16	0	31	
Lumbo-sacral	I	1	0	0	10	11	31
	II	4	0	0	16	20	
Sacro-iliac	I	7	4	3		14	97
	II	37	40	6		83	
Midsacral	I				0	0	1
	II				1	1	
Coccyx	I				4	4	4
	II				0	0	
Gluteal	I	1	0	0		1	
	II	6	10	2		18	

lumbar area (11 times), coccygeal area (4 times), dorsal area (2 times), and in the midsacral area, once. In a little over one-half the cases pain was noted as being in one area only. In the others several areas were complained of at the same time, these as a rule on the same side (Figs. 1 and 2).

Aside from the pain in the lower back, 149 cases complained of other pains radiating into the lower extremities; in 140, the pain followed down the posterior thigh and often into the outer aspect of leg and foot. Five of these, together with 9 others, who complained of no posterior thigh pains, complained of pain in the anterior thigh. These thigh and leg pains were noted as appearing on the right side 53 times, and the left side 60 times, and in both lower extremities 23 times; in 4 cases the side was not noted. These pains were always found on the same side as back pain or on the side where the back pains were severest. In 59 cases there were no complaints of leg pains.

When pains were present in more than one area there was noted a variation in the time of the onset. As examples of this these extracts from the following case histories may serve.

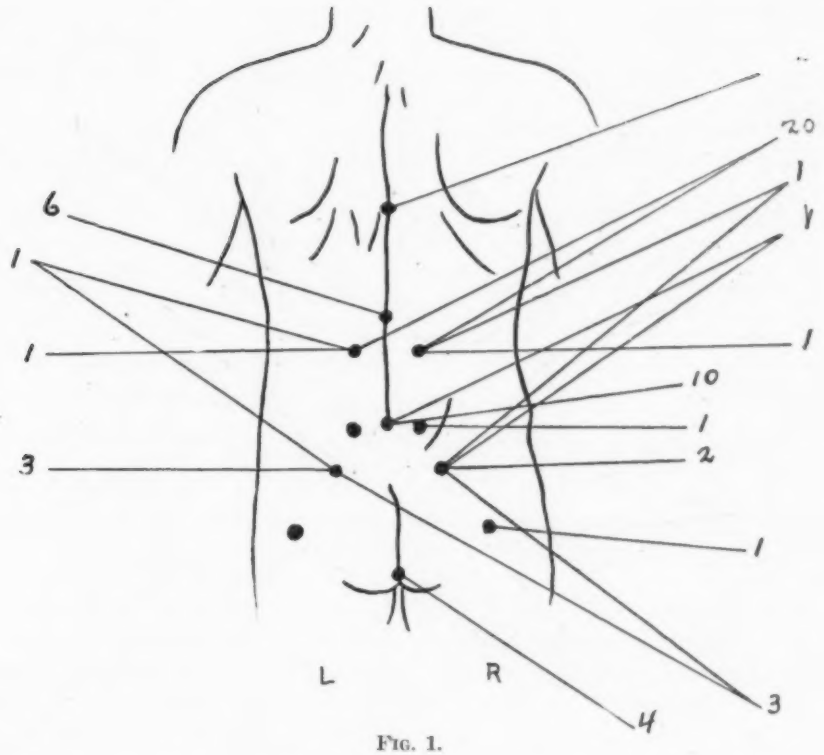


FIG. 1.

CASE 1. S. Male, age 36. A dull lumbar ache for one year, followed gradually by pain localized over the left sacro-iliac area.

CASE 2. G. Male, age 43. (1) Left lumbar pain. (2) After some weeks, a left gluteal pain. (3) Some days later, posterior thigh pain. (Following slight trauma. Marked static abnormality.)

CASE 3. G. Female, age 26. (1) General backache following a fall. (2) Some days later, pain over the left sacro-iliac area. (3) This was followed one week later by left posterior thigh pain. (Trauma.)

CASE 4. D. J. Male, age 41. (1) Pain in left lumbar area following a strain from lifting. (2) Suddenly, four days later, pain in the left sacro-iliac and gluteal areas and shortly thereafter pain in the posterior thigh. (Trauma.)

CASE 5. R. Male, age 35. (1) Pain midlumbar area, gradual onset. (2) Three days later pain in the left sacro-iliac area. (3) Somewhat later, pain in left posterior thigh. No trauma. (Static from an old fracture of the right leg three and one-half years previously.) Duration of symptoms, six months.

CASE 6. T. Male, age 26. (1) Sudden pain in the right gluteal area following a jump. (2) Ten days later sudden pain in right posterior thigh. (Trauma.)

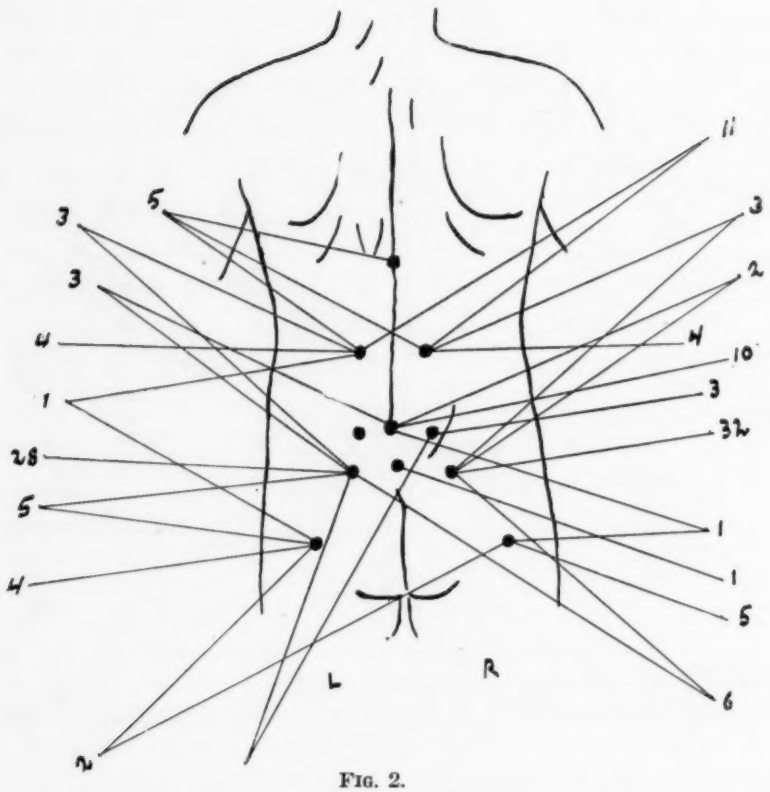


FIG. 2.

CASE 7. G. Male, age 42. (1) Pain in right gluteal area after pulling hard. (2) Gradually, after four days, pain in posterior right thigh. (Strain.)

CASE 8. M. Female, age 42. (1) Four months ago a bed fell on her left foot. (2) Ten hours later pain along outer aspect of left leg and posterior left thigh. (3) Shortly after this, lumbo-sacral pain. Sometime later this patient, a very intelligent woman, while sitting in a bath tub, found that flexing her left thigh with the leg extended, relieved the lumbo-sacral pain. She persisted in this exercise and states that this cured her lumbo-sacral pain. Her posterior thigh and leg pain, however, persisted. (Static?)

CASE 9. K. Male, age 43. (1) Dull ache over the sacrum, gradual onset, no trauma. (2) Gradually, two weeks later, left posterior thigh pain. (Occupational strain?)

CASE 10. M. Female, age 42. (1) Lumbar pain, gradual onset. (2) Two weeks later sudden posterior thigh pain. (Heavy, overhanging abdomen, very fleshy, static; chronic nephritis.)

CASE 11. M. Male, age 29. (1) Sudden pain in left sacro-iliac area

followed immediately by pain in left posterior thigh, after lifting a piano. (Strain.)

CASE 12. M. Male, age 32. (1) Lumbo-sacral pain, gradual onset five years ago. (2) One week later, gradual onset of pain in left posterior thigh and leg. At present, complete left paralytic drop-foot. So far as patient knows, the drop-foot has developed gradually. Lumbo-sacral pains persist. (Underground miner, static.)

CASE 13. H. Male, age 45. (1) Chronic backache for many years, off and on at short intervals. (2) High lumbar pain, bilateral, suddenly, two months ago. (3) Disappearance of this lumbar pain for two weeks after a rest. (4) Sudden pain in the right sacro-iliac area and in posterior thigh. (Osteoarthritis of lumbar spine.)

For purposes of further analysis, the cases are separated into three groups according to the distribution of pain:

Group I. 59 cases, those with back pains only.
Group II. 140 cases, those with low back pains and posterior thigh and leg pains.
Group III. 14 cases, those with low back pains and pains distributed other than down the posterior thigh and leg. Five of these later cases are also included in Group II.

Table No. 2 shows the character of pain as noted in the case histories. Pain aggravated by turning in bed or by rising from the lying or sitting position, or by lifting, stooping or walking and relieved by lying down is noted under the heading, "Pain worse on movement." Pain aggravated when lying down or sitting still and better when moving or walking is noted under, "Pain worse when quiet." One woman claimed relief from a chronic low back pain only when pregnant.

Movement in the back or lower extremities was found limited in many cases. In many this limitation was only in flexion of the spine, extension being free. In others both movements were more or less limited. In others again, lateral movements were mostly affected. By placing the patient on his hands and knees,—"on all fours"—flexion and extension of the lumbar spine could be easily obtained in many, actively and passively, demonstrating the condition to be one of short or spastic muscles. In the definitely arthritic spines the movements remained limited under these same conditions.

When the thigh, with leg fully extended, was flexed at the hip, limitation of this movement was noted in many cases. In many it was accompanied by a pain in the posterior thigh and leg or in the lower back. Hyperextension of the thigh at the hip was also limited in many of these cases.

A strikingly flat back, or a backward curve in the lumbo-sacral area,

was noted in some of the cases. In others, again, there was present a definite list of the body to one side or the other.

Table No. 3 shows the relative absence and frequency of the above findings.

In twenty-eight cases of Group II, all of the above mentioned findings were present. In thirteen of this group there were no other signs than the localized back pain and tenderness and the posterior thigh and leg pain.

Findings having a bearing on the etiology of these cases are listed under various headings in Table No. 6.

1. Under static factors were listed the following when at all marked: a short leg on one side; old fractures of the lower extremities with malalignment; deformity of the feet; excessively fleshy persons with large pendulous bellies; and very manifest cases of general fatigue, weakness and anemia. There were also included four cases in which the x-ray showed a definite lipping on one side of the body of the 5th lumbar vertebra. In the absence of any previous injury or signs of infection, these were interpreted as being static in character.

Case 14. Mrs. B. Female, age 36. Short, fleshy, housewife. Duration of symptoms five months. No previous attack. No known trauma. Pain in the right sacro-iliac and in posterior right thigh and outer leg. Straight leg raising restricted and painful on both sides. Slight limitation of motion in the lower back. Trendelenburg phenomenon present on the right side. Marked degree of flaccid flat-foot and ankle valgus on both sides. X-ray examination of spine and pelvis negative. Both hip joints normal. Operation for hyperthyroidism one year previously. A well-fitting corset; shoe alterations and gradual exercises were followed by a gradual but steady improvement. See also Case 5.

2. Those cases were considered traumatic in which symptoms followed upon falls, direct blows or upon sudden strains from heavy lifting. Also cases in which symptoms followed suddenly upon slight movement and those cases in which x-ray gave evidence of trauma.

Case 15. Mrs. C. Female, age 45. Strong, large, and fleshy. Duration of symptoms one month. No previous attacks. Following immediately on a fall on left lower back, large hematoma over left sacro-iliac area. Pain and tenderness over left sacro-iliac area. Limitation of straight leg raising, left more than right. Lower back movements limited in all directions. Pain radiating down left posterior thigh; pain very severe and worse on slightest movement. X-ray examination negative. Treatment by heat, massage, and graduated active exercises. Litigation. Gradual improvement in four months.

CASE 16. T. Male, age 37. Teacher, tall, thin. Duration one day. Previous attacks five, ten, fifteen years ago. Began suddenly and was caused by bending over to pick something from floor. Sudden pain in the right sacro-iliac area and posterior thigh pains. Straight leg raising restricted and painful, lower back movements slightly restricted. A narrow belt around hips above trochanters gives instant, complete relief.

3. Infections were considered, when local and general signs pointing to an inflammatory lesion of osseous, ligamentous, muscle or joint structures were present. Included were cases following cold and exposure; those in which osteoarthritic changes were found in the vertebral or pelvic joints by x-ray.

Furthermore, infection was suspected in those cases where definite foci of infection (tonsils, teeth, genito-urinary, etc.) were present and in all cases with complete limitation of joint movement in all directions.

CASE 17. M. Male, age 12. Tall, thin boy. Duration of symptoms two weeks. Severe pain in lower back and left posterior thigh and leg. No previous attack. No trauma. Pain in the left sacro-iliac area. Straight leg raising very limited and causes pain in left sacro-iliac area. Back movements limited in all directions. Backward curve in lumbo-sacral area. Pain, tenderness, and swelling in lower, left lumbar area. A short time previously he had been operated upon for mastoid disease and this was later followed by sinus thrombosis, and a little later by the present low back symptoms. Draining of a small abscess of the left erector spinæ muscle caused prompt and permanent disappearance of symptoms.

CASE 18. J. M. Male, age 25. Medium size, short, muscular. Duration of symptoms one month. Began suddenly, worse at night and when lying down, more comfortable when up. No previous attacks, no injury. Pain, tenderness, swelling and increased local heat over right sacro-iliac area and down the right posterior thigh. Straight leg raising restricted and painful on the right side. Walks with a forward stoop and stands with a list of the body to the left. Was given one dose of morphine sulphate, large doses of sodium salicylate, local applications and bed rest. This was followed by prompt improvement within a few days.

CASE 19. W. Male, age 28. Medium build, thin, but fairly muscular. Pain very severe on movement in lumbar area to both sides. Duration two months. Previous attack three years ago. No trauma. Pain alternately in right and left posterior thigh. Movements of the lower back limited. Leucocyte count 10,000. X-ray shows osteoarthritis in the body of the 5th lumbar vertebra. Plaster of Paris jacket worn with relief for a time. This was followed by a modified Taylor brace. Patient later went elsewhere and had a bone graft inserted into the

lower back. Improvement was slow when last seen about eight months after the bonegraft operation.

4. Cases following pelvic disease in women, or after operation for pelvic troubles, and those associated with pregnancy or parturition, are classed as gynecologic.

CASE 20. Mrs. F. Female, age 35. Married, music teacher, large frame, muscular, poorly nourished. History of many miscarriages. Pain and tenderness over both sacro-iliac areas with posterior thigh and leg pains for a long time and more or less steady. No trauma. No restriction of motion or pain on straight leg raising. No limitation of movement in the back. No deformity or deviation of body. States that she is free from these pains only when she is pregnant. Pelvic examination negative, Wassermann negative. Marked improvement after wearing properly fitting corset and a short course of anti-luetic treatment.

5. Five cases were associated with demonstrable nerve lesions.

Two cases had paralytic drop-foot (see Case 12), one of these following a severe injury with traumatic lesion in the 5th lumbar vertebra. One case (spina bifida) of mild paralytic pes equino-varus. One case had recurrent attacks of sudden pain and blanching in each great toe. One case with recurrent attacks of stiffness and pain in the lumbar area and with pain and weakness in both posterior thighs very much resembling an infectious arthritis. Symptoms of transverse myelitis of the cord gradually developed. At operation this proved to be a cystic (hemorrhagic) degeneration below the lumbar enlargement of the cord.

6. In five cases malignancy was considered as the probable cause. In one case (M., age 49, operated upon for carcinoma of the stomach one year previously) symptoms of pain and tenderness in the right lower back and opposite the right 5th lumbar transverse process, and in the left sacro-iliac area, and pain in the left posterior thigh of eight weeks' duration became progressively worse and death from metastases followed two months later. In a similar case the symptoms followed nine months after an operation for carcinoma of the breast, and continued progressively until death eight months later. In one, symptoms began some time after operation for suspected malignancy (ovarian tumor) and became progressively worse while the patient was under observation. The patient was later lost sight of. In two other cases the symptoms were those of marked osteoarthritis of the lumbar spine. In one of these the x-ray was typical of an extensive osteoarthritis but the patient became progressively worse and died of metastases ten months

later (sarcoma). In the other case death occurred, after symptoms had progressed steadily, in four months (no autopsy.)

7. Of the cases in which lues was a possible factor (history or positive Wassermann) two are given.

CASE 21. Mrs. V. Female, age 25. Married, housewife, large, strong, muscular. A fall off a step one year previously was followed by pain in the posterior left thigh and pain and tenderness in the right lower abdomen. (Appendectomy had been performed some two months before for this pain.) Similar attack some years previously. Straight leg raising was restricted and painful. Lower back movements free. Indication of Trendelenburg phenomenon on the right side; atrophy in the left calf. Wassermann 4+ repeatedly. X-ray examination was negative. Vigorous anti-luetic treatment was without effect.

CASE 22. M. Male, age 40. Married, salesman, large, fleshy, hypopituitary type. Five months ago pain gradually developed in the left gluteal area and extended down the posterior left thigh. No injury. No previous attacks. Fifteen years ago, chancre. Pain severe and continuous; worse on movement. Straight leg raising very limited and painful on both sides. No limitation of lower back (joint) movement, marked list of body to the right. Reflexes, inclusive of pupillary, normal. No pathological reflexes. Both lower extremities normal. Very apprehensive mental state. Blood Wassermann negative. Spinal fluid: cell count 11, Wassermann 3+, no globulin. Short anti-luetic treatment without any effect. Three weeks later, suicide.

8. Tuberculosis was a positive factor in two cases.

CASE 23. Mrs. J. Female, age 31. Tall, very emaciated. Pain and tenderness in the right sacro-iliac area and in the right posterior thigh. Began gradually four weeks ago. No previous attacks. No trauma. Straight leg raising limited on the right side. All movements of the lower back absent. Walks stooped forward. No deviation of body to the side. Trendelenburg phenomenon present on the right side. Walking and coughing causes pain over the sacro-iliac area. A soft swelling over the right sacro-iliac area. Active pulmonary tuberculosis. X-ray shows destruction at the right sacro-iliac joint.

CASE 24. R. Male, age 23. Gradual onset two months ago with symptoms of low lumbar pain of an indefinite character. Moderate limitation of movement of the lower back. Negative x-ray (Group 1). There appeared eight months later a large lumbar abscess showing the true nature of the process which had not been suspected.

X-ray examinations were made in all but thirty-four cases. In most cases the plates were found to be negative. Positive findings were noted as follows: Osteoarthritis of the lumbar spine, ten cases (seven in Group II); arthritic changes (lipping) in body of 5th lumbar vertebra,

nine cases (eight in Group II); anomaly of transverse processes of fifth lumbar vertebra, nine cases (five in Group II); spina bifida occulta, one case (Group II); arthritic change in one sacro-iliac joint (lipping of lower edge) in one case (Group II); and a roughening or spur formation on one iliac crest, one case (Group I). In three cases of Group II there was present an apparent widening of the sacro-iliac joint of one side. In one case (Group I) there was present a tear fracture of the end of the transverse process of the first lumbar vertebra.

Anomalies of the transverse process of the 5th lumbar vertebra included clubbing, sacralization, and impingement of the process. The following are brief case reports of these.

CASE 25. D. Male, age 38. Troubled off and on for three years. Pain in the right and left sacro-iliac areas. No posterior leg pains. Clubbed 5th lumbar transverse process.

CASE 26. R. Female, age 34. Four days' duration, similar attack two years ago. Present symptoms brought on by a very slight movement, reaching for something. Pain over the fifth right lumbar transverse process. Very free leg movements. Flexion and extension of the lower back limited. Pain constant, severe, on slightest movement. Enlarged right transverse process. This patient was very short and fleshy.

CASE 27. S. Female, age 23. Duration four years. Began gradually, following birth of last baby. Lumbo-sacral pain. Appendix removed for this trouble a short time ago. Very fleshy. Steady pain day and night, worse on walking. No muscle spasm. Left 5th lumbar transverse process clubbed with articular facet for sacrum.

CASE 28. P. Female, age 26. Tall, stooped, thin, enteroptotic. Many miscarriages. Lower backache. No limitation of straight leg raising. Movement limited in left lower back. Back flat. Body list to the left. Flexion causes prominence in left lower back. Flat-foot. Splay foot. Feet functioned well. Pelvis negative. Wassermann negative. Sacralized 5th left lumbar transverse process.

CASE 29. Female, age 33. Tall, thin, bony, poorly nourished. Six months' duration. Previous attack ten years ago. No trauma. Pain in left lower back. No limitation of straight leg raising. No symptoms of muscle spasm. Pelvic operation some years ago. At times lying down aggravates the trouble. Impingement of the left 5th lumbar transverse process.

CASE 30. C. Male, age 39. Three months' duration. No previous attack. No trauma. Trouble followed cold and exposure. Pain in the right sacro-iliac area. Limitation of straight leg raising on the

right. Back movements limited. List to the left. Sacralized 5th right lumbar transverse process.

CASE 31. P. Male, age 31. Tall and muscular. Two months' duration. Pain in the right and left sacro-iliac areas. Posterior thigh pains right and left alternately. Straight leg raising limited, right and left. Back movements limited. Flat back. Very marked list to left. No trauma. Prompt relief followed Buck's extension and plaster jacket. Enlarged 5th lumbar transverse process. (Six months later appendix removed.)

CASE 32. W. Female, age 38. Duration twelve years "most all the time." A direct injury fourteen years previously in which the coccyx was traumatised. Pains in the lumbo-sacral and left sacro-iliac areas. No limitation of straight leg raising. Back limited in flexion only. Deformed coccyx could be felt. A large club-shaped 5th lumbar transverse process right and left. Coccyx removed under local anesthetic. Complete immediate relief. No other treatment.

CASE 33. K. Male, age 34. Duration three months. Similar attack seven years ago. Sudden onset, no injury. Pain in the sacro-iliac area, the right worse than the left. Limitation of back movement. Tall and muscular. Sacralized 5th lumbar transverse process on the right side.

The following are other cases in which abnormalities were noted on radiographic examination.

CASE 34. C. Male, age 40. Medium size and build, poorly nourished and poor general musculature. Duration of symptoms four weeks. No previous attack. Began suddenly with no known trauma. Low lumbar back pain. Straight leg raising much limited on the right side and some pain over the area of the right 5th lumbar transverse process. Back movements all limited. Walks with a forward stoop. Recent acute attack of tonsillitis. X-ray examination shows spur formation on the right iliac crest. A few days later man returned stating that immediately after the examination his symptoms left him. No sudden phenomenon was noted by him during the examination. He has remained well since.

CASE 35. L. Male, age 30. Tall, muscular. Pain and tenderness over the right sacro-iliac area, six months' duration. Began gradually following a tonsillar abscess. Had an attack much like the present one some years ago. No trauma. Straight leg raising limited on the right side. Lower back movements all limited. Marked list of body to the left. Tonsils pathological. X-ray examination shows definite lipping of the lower edge of the right sacro-iliac joint. Case not followed.

Treatment of these cases was carried out by various means: 138 were treated by some form of mechanical support (pelvic and back braces, abdominal supports, corsets, canvas belts, and plaster jackets); 25 by correction of static abnormalities in the feet (shoe alterations); 18 by hyperflexing, under general anesthesia, the extended leg and thigh on the abdomen; 17 by leg extension (weight and pulley). In a few other cases bed rest and internal medication were used. In one, an abscess on a lumbar muscle was drained and in three a dislocated coccyx was removed (Case 32). All cases, except those definitely arthritic, were given active exercises for the back and lower extremities.

Improvement was at times very rapid and pronounced. This was especially true of all cases after forcible manipulation under ether, and twice by simple manipulation during examination. At other times the application of a simple strap above the trochanters, or a low, snug fitting corset or brace, gave relief no less prompt and complete.

In two cases, after forcible manipulation under ether, there followed no relief (one a probably malignant ovarian tumor, the other was later found to have osteoarthritis demonstrable by x-ray). In two other cases improvement was gradual and slow. In some cases treated in this manner there was noted a soft tearing (like tearing tissue paper), in others there was felt a sudden thud and a giving away of something.

These phenomena were usually followed by considerable local soreness, swelling, and ecchymosis in the posterior thigh. In two cases there was a sudden recurrence of the acute symptoms after a period of complete relief. In such instances the recurrence was brought on by a slight movement in leaning forward.

In most cases the improvement was very slow and gradual. In about 25% of all cases the patients were lost from observation after a short time and the improvement, therefore, not known. In ten, there was noted no improvement.

Death occurred in six cases, four were from malignant growths, one was from tuberculous meningitis and one was from degenerative spinal cord lesion.

COMMENT.

The proportion of males to females is nearly two to one (Table No. 4). This is probably not a true proportion, because, as stated before, there were examined many women (belonging mostly to Group I) of whom no records are available.*

*These comprise a series of cases, occurring in the practice of a gynecologist, in which the pelvic examination was negative.

GROUP	Pain worse when up, moving or lifting.	Pain worse when quiet, better when walking, etc.	Pain constant or severe.	Worse nights or early in the morning.	Worse in afternoon.	Cases not noted.
I	16	9	6	4	4	18
II	57	11	14	13	2	41
III	3	1	0	3	0	6
TOTAL	76	21	20	20	6	65

TABLE No. 2.

The cases were separated into groups because of symptoms only. Cases in Group II were generally more severe than those in Group I. In this series the males predominate in all groups. The greater chronicity in Group I is probably due to the relatively greater number of traumatic cases in Group II and because the cases in this latter group were of a more severe character, and therefore sought relief earlier. The physical characteristics of cases as noted in Table No. 5 show a very close parallel between Groups I and II. There is nothing noteworthy in the character of the pain (Table No. 2). It runs fairly parallel in Groups I and II. In most cases it is worse on movement. Relative to the location of pain (Table No. 1), it will be noted it lies in the area occupied by the erector spinæ group of muscles (origin, body, and insertion), 196 times in 220. The most frequent site is the sacroiliac area, especially in Group II. Study of the cases here given shows that there is nothing typical in the site of the pain, which would enable one to locate a lesion accurately. At times it was definitely shown that the lesion was at some other point.

It is interesting to note the sequence of the pain as given in Cases 1 to 13. These show the successive involvement of groups of muscles until several groups of one system of muscles have been involved. Very interesting in this connection is Case 8, in which the pain and limitation of movement extended upward, and not downward, as occurred in all other cases. This woman, after sustaining an injury to a foot in the forenoon, walked much while shopping all the afternoon, and

GROUP	Lim. of movt. in lower back.		Lim. of str. leg raising.		Flat back, backward curv. lower back.		Body List.	
	No	Yes	No	Yes	No	Yes	No	Yes
I	39	15	42	7	43	3	42	2*
II	38	84	35	93	61	39	72	39**
III	5	7	9	2	8	5	11	3
TOTAL	82	106	86	102	112	47	125	44

* Once toward the painful side.

** 4 times toward the painful side.

TABLE No. 3.

felt the pain in the posterior thigh come on ten hours after the primary injury.

In Table No. 3 it will be noted that there is a definite parallel between cases having limitation of lower back movement and those having limitation of straight leg raising, and between these cases and those with posterior thigh pains (Group II). The occurrence of flat back and backward curve, as well as of the list of the body to one side, is characteristic of Group II. All positive findings in Table No. 3 are manifestations of muscle spasm or of muscle shortening. They were present under varying conditions and their presence gave no clue to the underlying cause (*e. g.* traumatic, infectious, static).

The association of posterior thigh pains with low back pains is well known. These pains are often spoken of as being sciatic in origin. The list of the body to one side which is frequently found in these cases has been called sciatic scoliosis, the list or "scoliosis" being considered secondary to the sciatic pain.

The posterior thigh pains, while very suggestive of a sciatic nerve distribution, in nearly all cases, give positive evidence of sciatic origin in only very few cases—(Case 12 and four others briefly noted on page 360 *ff*). Of these cases, Case 12 is the only one not associated with a severe traumatic lesion of the lower spine or with a primary nerve or cord lesion. A few other cases complained of paresthesia on the outer aspect of a leg or foot, but in these there was no objective sign of nerve lesion. In only thirteen cases of the whole series in which these posterior thigh pains were present, was an absence of muscle spasm noted.

GROUP	Males	Females	Duration to date	Previous attacks		Trauma		Associated with childbirth.
				Yes	No	Yes	No	
I	36	23	27 mos. (53 cases)	18	31	15	27	5
II	96	44	11½ mos. (121 cases)	57	63	55	44	0
III	(9)* 6	(5)** 3	10 mos.	5	6	5	6	1
TOTAL	138	70		80	100	75	77	6

* 3 counted twice.

** 2 counted twice

TABLE NO. 4.

Bilateral leg pains in cases with osteoarthritis were undoubtedly of nerve root origin. Case 22 may have been one of cord lesion.

In the greatest number of cases these leg pains followed after all other symptoms (muscle spasm) had put in their appearance, and were relieved as these other symptoms disappeared. In many cases the hamstring muscles were often noted as being tender on palpation.

GROUP	Tall or short but muscular and strong.	Fleshy, overweight.	Thin, but wiry.	Tall, thin and weakly.
I	21	15	2	13
II	66	35	5	12
III	6	5	0	2
TOTAL	93	55	7	27

TABLE NO. 5.

GROUP	Static	Traumatic	Infectious	Gynecologic	Neurologic	Malignant growths	Lues	Tuberculosis	Congenital anomaly
I	26	2	11	2		0	1	1	0
II	30	24	20	7	5	5	4	1	1
III	6* 4	1	2	0		2*	0	0	0
TOTAL	60	27	33	9	5	5	5	2	1

* 2 counted twice.

TABLE No. 6.

Reference to Table No. 6 shows that in one hundred and forty-seven cases in which the records were complete, over 80% are classed as static, traumatic, or infectious in origin. Of these, over one-half are classed as static, and the other half nearly evenly divided between the traumatic and the infectious.

The static group, in the writer's opinion, is probably greater than here stated. Thus, most cases classed as gynecologic and obstetric are really static in origin and nature. In a severe case, manifesting all the typical symptoms that have been discussed, one may elicit a history somewhat as follows: From the sixth month of pregnancy on, a more or less gradual but insistent low backache followed by posterior thigh and leg pains; parturition follows normally and the pains improve and disappear; two weeks later the new mother leaves her bed, and after a further two weeks the nurse is discharged and the mother takes over the care of the baby with all the bending over and stooping forward which such care demands. The symptoms all gradually develop anew. During the latter months of pregnancy the posterior back musculature is overtaxed by the rapidly increasing anterior load, and is not functionally fit to cope with the new demands made upon it. In Case 14 the previous hyperthyroidism probably played an important rôle in weakening musculature to a considerable degree. The term "insufficientia vertebrae" is very apt. It is probable that not a few individuals go through life handicapped by this condition. About 44% of all cases give a history of previous attacks (Table No. 4).

While trauma was given by the patient as a cause in about one-half of the cases, it was considered to be the chief cause in a little over 18% (Table No. 6). Nearly all cases belonged to Group II. It is possible, as Lovett suggested, that cases following very slight trauma may be really arthritic. In the absence of positive x-ray evidence, there is nothing to indicate the exact site of injury, or the tissues injured.

In this series there was no case which the writer felt was due to sacro-iliac relaxation or subluxation. If, following muscle insufficiency (as in weak foot), the strain is thrown upon ligamentous structures, there would follow a strain not only in the sacro-iliac structures, but also in the structures of other joints equally involved. It is probable that this occurs frequently. (Insufficientia vertebræ.)

The frequency of anomalies of the 5th lumbar transverse processes has been variously estimated. Thus, Nové-Josserand and Rendu[1] in four hundred cases in which x-rays were made at random, found such anomalies present in 7 or 1.7%. In eight hundred cases with lumbar pains, they believe the symptoms might be attributed to the anomaly in twenty-two, or 2.7%. In the two hundred and eight cases of this series they were present in more than 4.3%.

In the nine cases (25 to 33) there is none, except possibly Case 26, in which the symptoms can, with any degree of probability, be attributed directly to such an abnormality. The symptoms in Case 32 certainly had nothing to do with the anomaly which existed.

Cases in which the arthritic manifestations are slight, are difficult of detection. It is probable that these cases are the ones most chronic and most subject to recurring attacks.

Cases in which lues was suspected were uninfluenced by anti-luetic treatment, and were undoubtedly of other etiology. Case 22 may have been one of beginning spinal cord lues. Aside from the very meagre findings in the spinal fluid there was nothing in the case to distinguish it from other typical cases of other etiology. Kennedy and Elsberg,[2] in discussing "a peculiar undescribed disease of the nerves of the cauda equina," refer to cases which, in their beginning, are very similar clinically to many of the cases in this series, and which later show definite muscular and sensory changes in the lower extremities. At operation in these cases an inflammatory condition of the cauda equina was found.

The case referred to on page 361 is very suggestive of this condition: a young man, age 32, was seized with a severe pain in the lower lumbar and lumbo-sacral region. He attributed this to a drenching after a hard day in the woods. The severity of the pain persisted for two days.

The pain was worse when he was sitting or lying down, and better on walking; gradually it extended to the legs and feet, continuing so for three weeks. During the next month he worked little; there was a tendency to fall easily. Two months after the first symptoms he became chilled again. A dull ache throughout the lower back and legs followed this. He could get no relief and was unable to work. From the beginning of his trouble his bowels were constipated and he had difficulty in passing water. Two months after the onset the patient was seen by an associate during the writer's absence in the service. At this time there were no positive neurologic findings. Two and a half years later the man came under observation again, this time with symptoms of a rapidly progressing transverse cord lesion.

Tuberculosis, because of its relative frequency in the lower back, its chronicity and its insidiousness, should always be kept in mind. Had more attention been paid to the previous history and to certain other apparently minor factors, a disastrous result in Case 24 might have been averted.

Cases of this series occurring in the presence of growths of known malignancy, and in which the symptoms are continuous and progressive, and uninfluenced by treatment have, except one which was lost from observation, all ended in death. In one, the malignant feature was only suspected, in another (radiographic signs of typical osteoarthritis) the true nature was unsuspected until the appearance of metastases.

The sudden relief which was experienced in some cases by a slight movement, or by a forcible manipulation is, in the writer's opinion, comparable to the sudden relief experienced in stiff and painful shoulders after similar movements or manipulations. In these shoulders the lesion is generally periarticular and the improvement dependent upon the breaking up of the adhesions. In stretching some of these legs under anesthesia there was noted a sensation of tearing which suggested very strongly the presence of adhesions somewhere at or above the insertion of the hamstring muscles. In several cases which suddenly gave away with a thud the writer imagined the phenomenon depended possibly upon the bursting of a distended sac (bursitis). The force used in these cases was certainly not enough to tear a large muscle from its attachment.

In many cases the improvement was slow, and in many who were lost from observation the progress was probably not satisfactory. In some cases there is a strong neurotic tendency and in these the recovery is notoriously unsatisfactory. The same is true in cases with damage suits pending and compensation claims to settle.

CONCLUSIONS.

1. Any injury or disease affecting the lower back structures (muscular, ligamentous, bursal, osseous or joint) may give rise to a similar symptom complex in cases of chronic low back pains.

2. Unfavorable static conditions in the lower back or extremities resulting from abnormalities in the lower extremities, postural or occupational strains, or from fatigue or weakness, frequently exist in these cases and operate as a cause in the production of symptoms either alone or in conjunction with other causes.

3. In all cases of low back pain, the possibility of a progressive disease of the spine or of the spinal cord should be kept in mind.

4. The best results from treatment were obtained in cases in which static abnormalities were corrected, in which lower back structures were protected or put at rest, and in which such structures, if shortened, were stretched.

5. Graduated systematic exercises are an important adjunct in the treatment of many of these cases.

REFERENCES.

1. Presse Méd., July 20, 1920. Abstracted in Practical Medicine Series, vol. iv, series 1920. The Year Book Publishers, Chicago.
2. The American Journal of the Medical Sciences, May, 1914, No. 506, vol. cxlvii, No. 5, p. 646.

SIMULTANEOUS HYDROPS OF THE KNEES.

BY HENRY J. FITZ-SIMMONS, M.D., BOSTON, MASS.

BILATERAL swelling of the knees, coming at the same time or closely enough to be practically at the same time, is rather uncommon. In this paper, a clinical analysis has been made and cases tabulated, in an attempt to find common factors. In examining the records of a large hospital clinic, it was possible to find but thirteen cases which could be classed as hydrops simultaneously observed in both knees. These cases were taken from a clinic which admits only children under thirteen. The clinical study was begun with the idea of placing the proper diagnostic value on this type of knee swelling.

There are certain factors in examining such cases which must be kept in mind. These have been used in this study as the framework upon which to base a clinical diagnosis. They are:

What was the first symptom noted?—whether pain, swelling, heat, redness, or functional disability.

Was this first symptom preceded by any infectious condition or trauma; or had a similar condition ever previously been noted in the joints under observation, or in any other joints?

Have the joints shown improvement at any time? Have there been remissions in severity of pain?

The family history of the patient may give added information concerning an inherited taint. The health of the parents at the present time and previous to the birth of the patient may be of great value.

The maternal history as regards miscarriages and, if any, when they occurred with reference to the birth of the patient. The health of the present living brothers and sisters must be gone into in detail in regard to systemic constitutional ailments. The cause of death of any children should also be known in as great detail as possible.

The history of the patient from the time of birth, in relation to nursing, prevalence of colds, or the presence of lowered resistance, should be noted.

The course and progress of the condition under treatment should also be noted.

The physical examination should discover the presence or absence of syphilitic stigmata, as well as the more evident manifestations of pathology.

TABLE 1.

ELEVEN CASES OF SYMMETRICAL SYNOVITIS OF THE KNEE.

No.	Sex.	Age.	Joints.	Duration of symptoms.	Evidence of hereditary syphilis.	Family history.
1	M.	10	Both knees.	4 months.	Double interstitial keratitis; typical teeth; ostitis of both tibiæ.	No notes.
2	F.	8	Both knees.	6 months.	Double interstitial keratitis; ostitis of one tibia.	No history.
3	M.	11	Both knees.	6 weeks, and then ceased attending.	One typical central incisor; nodes on tibiæ; snuffles and skin eruptions in infancy.	Mother had two stillborn children before patient.
4	F.	9	Both knees.	3 months.	Interstitial keratitis of one eye of two weeks' standing, with no further notes; one typical central incisor.	No history.
5	F.	20	Both knees (two years apart).	6 months each.	Remains of double interstitial keratitis; ostitis of both tibiæ, which are very large.	No history.
6	F.	10	Both knees.	7 months.	Double interstitial keratitis; typical teeth.	Father syphilitic; no evidence in family beyond patient.
7	F.	15	Both knees, and right articular tenderness.	6 months.	Double interstitial keratitis under Mr. Nettleship; incurable deafness of one month's standing.	No history.
8	M.	14	Both knees, articular tenderness.	3 months.	Interstitial keratitis; typical teeth; deaf.	No notes.
9	M.	12	Both knees.	2 months, and probably more.	Interstitial keratitis.	Well-marked history of mother being infected, and thus having miscarriages.
10	F.	8	Both knees acute and painful one week after fall on knees. One joint tapped. Recovered with good joints.	4 months.	Double interstitial keratitis.	Doubtful history.
11	M.	31	Both knees. History also of both ankles having been swollen at commencement.	12 months.	Double interstitial keratitis for nine months; still under observation.	Patient is third child; fourth, fifth, sixth, and seventh children died in infancy; eighth under observation for interstitial keratitis.

TABLE 2
TUBERCULOUS

Name	J. G.	M. S.	F. S.	G. B.
Age	3	5	2	8
Duration at first examination	18 mos.	12 mos.	3 weeks	2 mos.
First symptom noted	Swelling	Swelling and pain	Swelling and pain	Swelling
Onset	Acute-non traumatic	Insidious	Gradual	Insidious
Fever at onset	Yes	No	Yes	Yes
Constitutional symptoms	None	None	None	Weakness
Other joints involved	None	Ankle	Hip and spine later	None
Swelling at first examination	No	Yes	Yes	Yes
Surface temperature	Yes	Yes	Yes	No
Increase of fluid in joint	No	Yes	Yes	Yes
Increase in circumference of joint	Yes	Yes	Yes	Yes
Bony thickness	Yes	Yes	Yes	No
Atrophy above joint	Yes	Yes	Yes	Yes
Motion	Markedly limited	Markedly limited	Markedly limited	Limited
X-ray evidence of tuberculosis	Squaring of condyles	Squaring of condyles	Squaring of condyles. Bone atrophy of size and substance	Not obtained

TABLE 4
POSITIVE SYPHILITIC

Name	H. L.	N. R.	J. N.	W Y.
Age	8 2/3	6	10	3 3/12
Duration at first examination	30 mos.	3 mos.	3 weeks	3 mos.
First symptom noted	Pain and swelling—night	Swelling and pain—night	Swelling	Swelling
Onset	Insidious	Insidious	Insidious	Insidious
Fever at onset	No	No	No	No
Constitutional symptoms	Weakness	Weakness	Weakness	Weakness
Other joints involved	Ankles	None	None	None
Swelling at first examination	Yes	Yes	Yes	Yes
Surface temperature	Slight	No	No	No
Increase of fluid in joint	Yes	Yes	Yes	Yes
Increase in circumference of joint	Yes	Yes	Yes	Yes
Bony thickness	Yes	Yes	Yes	Yes
Atrophy above joint	Yes	No	Yes	No
Motion	Very slightly limited	Very slightly limited	Very slightly limited	Very slightly limited
Von Pirquet	Negative	Negative	Negative	Not obtained
Wassermann	Doubtful	Doubtful	Triple plus	Not obtained
Evidences of syphilis	X-ray appearances (Father acknowledges lesion)	X-ray appearances. Indolent ulcer on leg	X-ray appearances. Interstitial keratitis	X-ray appearances. Ulcer on leg. Perforation of palate

TABLE 4-A
SUSPECTED SYPHILITIC

Name	W. St. G.	S.	E. O.
Age	2	9	7 years, 10 mos.
Duration at first examination	3 months	12 months	5 years
First symptom noted	Swelling and deformity	Pain and swelling—night	Pain and swelling
Onset	Acute	Three days after accident	Not known
Fever at onset	No	No	Yes
Constitutional symptoms	None	None	Delicate
Other joints involved	None	None	None
Swelling at first examination	Yes	Yes	Yes
Surface temperature	No	No	Slight
Increase of fluid in joint	Yes	Yes	Yes
Increase in circumference of joint	Yes	Yes	Yes
Bony thickness	Yes	No	Yes
Atrophy above joint	Yes	No	Yes
Motion	Limited	Slightly limited	Limited
Evidence of syphilis	X-ray appearances	Two miscarriages	

TABLE 3

NON TUBERCULOUS, NON SYPHILITIC INFECTIOUS

Name	F. W.	J. P.
Age	12	8
Duration at first examination	7 months	4 years
First symptom noted	Pain in hip. Swelling in knee	Swelling
Onset	Acute	Acute
Fever at onset	Yes	Yes
Constitutional symptoms	Systolic murmur	None
Other joints involved	None	Wrist
Swelling at first examination	Yes	Yes
Surface temperature	Yes	Yes
Increase in fluid in joint	Yes	Yes
Increase in circumference of joint	Yes	Yes
Bony thickness	No	Yes
Atrophy above joint	No	Yes
Motion	Limited	Limited

In the local examination, should be noted signs of inflammation about the knee. Bony should be differentiated from capsular thickening. The motions should be tested in comparison with the normal.

In this series of thirteen cases, it has been thought rational, owing to the time which elapsed during the first observation and the last, to classify them clinically into three groups. The first group, which contains four cases, were considered tuberculous (Table 2). The two cases in the second group were of an infectious nature, but were not considered to be tuberculous or syphilitic (Table 3). The remaining seven cases, four of which were considered syphilitic and three probably syphilitic, have been grouped together (Tables 4 and 4a).

In those that were considered tuberculous, the average age was four years and six months. The duration of the symptoms, previous to the first examination, averaged about eight months, the longest having gone eighteen months with symptoms of such a benign nature as not to necessitate a hospital visit. The shortest duration of symptoms before the first examination was three weeks. All these cases noted swelling as the first indication of trouble, and in two cases this swelling was accompanied with pain. In one case, the onset of the symptoms was very acute, and in the remaining three, insidious. Fever accompanied the onset of the symptoms in three cases and was absent in one. None of these cases, with the exception of the one that I have marked "G. B.," showed any constitutional symptoms in the beginning. The knees were the only joints affected in two cases; and in the other two cases the knees were followed, by the ankle in one, and the hip and spine in the other. All four cases showed in the beginning a marked surface temperature at the knees, with an increase of fluid in the joints in all but one case,

which later developed fluid. Naturally there was also a marked increase in the circumference of the joints. There was bony thickening in three cases, but in the one marked G. B., "suspected tuberculous," this bony thickening was absent. Atrophy in the lower end of the femur and the lower leg was a constant symptom in all cases, with motion markedly limited in all from the beginning.

In Table 3 are shown two cases which differ from those considered tuberculous or syphilitic in that pain, as well as swelling, was a beginning symptom; that the onset was acute; that fever was present; and that in one case constitutional symptoms and a heart lesion were present, although there were no marked constitutional symptoms in the other. In one case, the infection was confined to the knees solely, while in the other, an infection in the wrist complicated the original infection. Surface temperature, increase of fluid in the joints, and increase in the circumference of the joints were constantly present in both cases. Atrophy and bony thickening were present in one and absent in the other, while motion was limited in both from the beginning.

Tables 4 and 4a show the findings in the syphilitic or suspected syphilitic cases. The average age was almost seven years, which is considerably older than in the other cases. The average time of duration varied from five years to three weeks. With the exception of the two extremes, it averaged about ten months before the symptoms caused the patients to be brought for examination. Of the cases that were considered positively syphilitic, pain and swelling were present in two, and swelling alone in two, without pain. In the cases in which pain was present, this pain was worse at night. The onset in each case of this group was insidious. At no time was there fever, and all showed evidences of constitutional weakness. In three of the cases, the knees alone were infected, and in one case, the knees and ankles. No surface temperature was present except in one case where it was very slight. An increase of fluid and an increase in circumference at the joints were found in every case. Bony thickening was absent in three of the cases and present in one, while atrophy was present in two and absent in two. Motion was free, or only slightly limited, in all. In Tables 4 and 4a, swelling was observed in all, while pain was observed in two, one of these cases showing marked pain at night. The onset of the symptoms was acute in two cases, and not known in the other. Fever was absent in two and present in one. At the onset of the trouble, no constitutional symptoms were noticed. The knees were the only joints affected and showed swelling, increase of joint fluid, increase in joint circumference. There was absence of surface tem-

perature in two cases and slight surface temperature in one. Bony thickening and atrophy were present in two and absent in one. Motion was limited in two, and slightly limited in one.

An interesting clinical point noted in the comparison of those considered tuberculous with those considered syphilitic was that pain, as a symptom early observed, was slightly more prevalent in the former. The onset in both groups was, as a rule, insidious or gradual. Fever was present more frequently in the tuberculous group than in the syphilitic. The constitutional symptoms, as expressed by general weakness and tire, were earlier observed and more constant in the syphilitic than in the tuberculous group. Other joints in this condition seemed to be involved more frequently among the tuberculous cases than among the syphilitic. Surface temperature, bony thickening, and the limitation of motion were all more marked in the tuberculous than in the syphilitic. The expression of a more rapidly destructive process was evidenced more in the tuberculous than in the syphilitic group.

Only in the cases enumerated in Table 3 was there any infectious or recent traumatic factor which preceded the onset of the symptoms. In a small proportion of the total number of cases listed under Table 2 there was a vague history of a similar condition in the past involving the knee joints. The joints have also, in this tuberculous group, shown remissions in severity during the progress of the disease. The family histories of the cases on Table 4 showed, in two instances, presence of miscarriages and other syphilitic stigmata, and also the same conditions were observed in two cases that were considered tuberculous. The health of the present living brothers and sisters offered no increase in knowledge, nor did the cause of death of other children in the families of these patients offer definite data upon which to hazard suspicion. The thirteen cases under observation all had the benefit of maternal nursing, so, it is fair to presume, started life without the handicap of artificial feeding. The final clinical test of the progress of the condition under treatment showed that the cases marked "positive and suspected syphilitic" were all improved under the use of mercury and iodide. Those considered non-syphilitic did not so improve, but did respond, as non-specific joints do, to appropriate treatment of fixation and general hygiene.

The knees in group three (Tables 4 and 4a) differed from those in the other groups. They seemed full, but not tense, and gave a feeling of soft fluctuation on palpation. The bones, entering into the formation of the joints, were not enlarged, and the roentgenographic appearances showed no atrophy nor definite destruction of joint surfaces.

This lack of destruction and the chronicity of the synovitis, with ultimate excellent functional result, is characteristic of the syphilitic joints, and not of the others.

Mr. H. H. Clutton, in the *Lancet* of February 27, 1886, page 391, states that he believes symmetrical synovitis of the knee is due to hereditary syphilis and always shows evidence, either past or present, of the diseases. In his cases, shown in Table 1, the predominant features were symmetry of the affection, freedom from pain, the long duration of the symptoms, and the free mobility of the joints on passive motion throughout the course of the disease. A summary of his belief is included in this statement, "I have never seen both knee joints filled with fluid, causing scarcely any pain or discomfort, whilst other joints remain free from any signs of inflammation, except in cases where there was distinct evidence, past or present, of hereditary syphilis."

Dr. Abner Post in the *Boston Medical and Surgical Journal* of December 23, 1915, vol. clxxiii, No. 26, in an article on "Symmetrical Synovitis in Hereditary Syphilis," draws the same conclusions.

Conclusions: From the analysis of the thirteen cases studied, it must be concluded that symmetrical synovitis of the knee may be due to tuberculosis, trauma, or some infectious agency of a non-tubercular or non-syphilitic nature. However, symmetrical synovitis of the knee, chronic in nature, free from marked discomfort, and without bony thickening, which permits almost painless motion of the joints during the course of the disease, and an ultimate excellent functional result, is due probably to hereditary syphilis.

LOW BACK PAIN—A CLINICAL STUDY OF ITS CAUSE.

BY JOHN TOLSON O'FERRALL, M.D., NEW ORLEANS, LOUISIANA.

THE Orthopedic Clinic of the Touro Infirmary offers great opportunity for the study of low back pain, because of the large number of laborers applying for treatment. The author fully realizes the great diversity of opinion existing in regard to the cause for such conditions, and with this fact in mind, a review of forty recent cases has been attempted.

In my opinion, this condition has been approached, in the past, with such great respect for the severity of the condition, that the true clinical facts have been overlooked, and preconceived ideas of the parts involved have overshadowed the real anatomy of the lumbo-sacral region. This is almost entirely true of the general practitioner and the general surgeon.

A brief résumé of the anatomy of the lumbo-sacral joint will indicate, primarily, that we are dealing with a very unstable structure. "The lumbo-sacral articulation in its main part inclines downward and forward,—about thirty degrees when the person is standing erect, and except for the articular processes at the back, the spine would naturally slide forward upon the sacrum. The ligaments under normal conditions represent considerable support, but they would naturally be stretched in a short time and displacement of the bones take place, except for these articular processes. The lumbo-sacral joint is capable of considerable motion, fully one-half of the motion of the trunk below the dorsal region being made in this articulation and in the one just above it. In forward bending, the motion of the lumbo-sacral joint is made chiefly by the articular process of the 5th lumbar vertebra sliding upward upon the opposing processes on the sacrum,—habits in which the back is flattened must result in making the long axis of the sacrum more nearly vertical, and consequently the lumbo-sacral articulation more nearly horizontal. In this position the inter-spinous ligament in the lumbo-sacral portion of the spine must be stretched. With this, naturally, the motion at that joint will be more free and the articular process must be drawn more or less apart." (Goldthwait)

Secondarily, the stability of this joint depends upon the two articular processes, and mainly upon ligamentous support. The principal ligaments being, first, the lumbo-sacral ligament, arising from the

lower front part of the 5th transverse process, and being attached below to the lateral surface of the base of the sacrum; second, the ilio-lumbar ligament arising from the tip of the 5th transverse process and attached to the crest of the ilium. This condition exists on both sides of the lumbo-sacral joint, requiring four major ligaments and several minor ligaments to support this joint.

It must be further remembered that the lumbo-sacral cord,—which is made up from the roots of the 4th and 5th lumbar plexus, supplying the sensation to the buttocks, anterior and posterior aspects of the thigh and the sciatic region,— passes just under the transverse process of the 5th lumbar vertebra, and in intimate contact with the lumbo-sacral and ilio-lumbar ligaments.

Many anatomists tell us, and the x-ray of many lumbo-sacral joints show that the 5th lumbar vertebra varies in its articular processes and in the size and shape of its transverse processes. The variability of the articular processes would indicate a greater weakness of the lumbo-sacral joint, while the size and shape of the transverse processes do not influence greatly the ligamentous attachments. Many flat x-ray plates indicate an impingement of the transverse processes on the sacrum or ilium, but only stereoscopic plates can prove the true conditions.

Therefore, the foregoing brief anatomical description plainly indicates that the lumbo-sacral joint is distinctly a pivotal joint, upon which devolves all the motion of the trunk on the pelvis, the pivotal motion at this joint being produced by muscle contraction and expansion, but being controlled and limited by the ligamentous guy ropes which are short, powerful, and firmly attached. When in the erect position, the poise or posture of the body is maintained largely by the muscles, assisted at the lumbo-sacral joint by the two articular processes against the sacrum, the ligaments in this position being largely free from their duties of stabilization. However, in the position of forward bending, the lumbar spine is flattened, which renders the lumbo-sacral articulation (horizontal in the standing position) vertical, and calls upon the ligaments for the stability of the lumbo-sacral joint, assisted by the flattened, stretched muscles in and around the lumbar spine. While the trunk, in this position of forward bending at approximately a right angle to the sacrum, is a heavy load to hold, yet these lumbo-sacral ligaments are designed to maintain stability so long as the muscles assist and extra weight is not added; but should the muscles give away but for a second, the entire burden falls upon these lumbo-sacral ligaments. If, as in the momentary relaxation of

the posterior muscles of the spine, preparatory to lifting or pulling, this problem of stability devolves entirely upon the lumbo-sacral ligaments, with the added weight, the result invariably is a sprained or strained ligament. The sprain, in my opinion, does not differ from the ordinary sprained ankle (lat. lig.) or knee. The same type of structure (non-elastic ligament) is involved, the onset is sudden (a slipping sensation), the pain quite intense, and rapid swelling ensues. This swelling of the lumbo-sacral and ilio-lumbar ligaments is often sufficient to produce pressure and edema of the lumbo-sacral cord, which passes just under these structures, and in consequence, pain over the distribution of a part of the sacral plexus and the sciatic nerve takes place. The spinal and lateral spinal muscles are thrown into spasm in an effort to fix the lumbo-sacral joint and the adjoining painful area, the rigid spine, therefore, indicating that the lumbar spine or some adjacent part has been injured. It should also be borne in mind that such a strain untreated, or improperly treated, will become chronic and consequently of much longer duration than the acute condition, and more difficult to relieve.

Bony anomalies in relation to the lumbo-sacral joint are of, in my opinion, secondary importance. The stability of the joint is entirely dependent upon the normal anatomic structure. If an enlarged or elongated transverse process of the 5th lumbar exists, it would not influence the sprain above described, unless it were unusually long and a fracture produced. If a false joint between the ilium or sacrum, and a transverse process existed or if a bony union between these structures occurred, such would not prevent the sprain of the lumbo-sacral ligaments but, on the contrary, would add seriousness to the situation and intensify the sprain and the consequent inflammatory reaction.

If careful search is made when examining our cases it is rarely that we find a patient who has no active intercurrent infection. The focus may be the nose, the throat, or the teeth; or, further, a focus may exist in the abdomen or the genito-urinary tract. This last named source of infection may be the remains of a Neisser infection or the point at which the spirocheta palida has gained entrance into the blood stream. It is a well-established fact that if an intercurrent infection exists and an injury to any bone, joint or ligament occurs, that the lowered resistance of that part permits the infection or its toxins to attack that part and there form a more decided pathological lesion. In many instances if the infectious foci are cleared up the traumatized

part, whether by injury or operation, more promptly responds to recognized methods of treatment, or is capable of effecting its own cure.

Nothing has been so clearly demonstrated during the recent war, to those uninitiated in orthopaedic surgery, as the prime necessity for the fixation of traumatized parts, whether open or closed. If the wound is open, fixation reduces the pain and shock and retards contamination and later infection. If the wound is closed, such as an injured joint, the fixation puts the traumatized soft parts and strained ligaments at immediate rest, which means, if not too prolonged, ultimate restoration to normal. Hence in the lumbo-sacral strains, in addition to clearing up existing foci of infection, we resort to the common orthopaedic practice of fixation to relieve the ligaments of strain and putting them at rest, depending upon the muscles for poise or balance. In such conditions transverse and vertical strapping with adhesive plaster, fixing the pelvis and lumbar spine as one unit, is usually sufficient to give prompt relief. It is necessary, however, to reapply this as it loosens. If complete fixation is required, the application of a plaster jacket is indicated.

In reviewing the forty cases reported in the attached table it is readily seen that lumbo-sacral pain is much more common in men than in women. (If the sacro-iliac joints were at fault pain should be more common in women, especially during the ages of child-bearing). The proportion is thirty-four men to six women. The vast majority of the men were laborers, the remainder being clerks or having similar occupations requiring bending forward and lifting. The women were largely of the negro race and engaged in the occupation of laundress or cook, either of which calls upon the lumbo-sacral joint for much strain.

The onset of the pain in twenty-two of the cases was sudden and occurred while stooping or lifting or immediately after executing such a movement, such occurrences pointing to the fact, emphasized in a foregoing paragraph, that in stooping or lifting a momentary relaxation of the muscles took place preparatory to lifting and all the strain was placed upon the lumbo-sacral ligaments, a real sprain of these ligaments taking place. In the remaining 18 cases the onset was insidious, this being due to the gradual progress of disease or infection and in some of the cases occurring after periods of heavy labor but not referred to by the patient when giving his history. It also happens that the patient is of inferior mentality and a clear history is difficult to obtain, it being found later that several such strains have occurred

during the so-called insidious onset that should be looked upon as lumbo-sacral in character.

Localization of the pain to me is very striking. Thirty-seven cases definitely designated the lumbo-sacral joint or the lumbo-sacral angles as the point of pain and in each instance tenderness existed at this point or points. Two designated the left hip and thigh and leg as the site of pain, which was probably referred pain due to pressure of the lumbo-sacral cord from swelling of the lumbo-sacral ligaments. One case referred his pain to the sacrum.

Examination revealed that spasm of the spinal muscles existed in some decided form, varying from slight restriction of the spinal motions to complete rigidity, including also so-called "sciatic-scoliosis," in thirty cases. The spinal motions were free and painless in nine cases and in one case no record was made.

Inspection of the teeth showed that infective foci existed in the form of necrotic teeth, crowns and fillings (potential infectious foci) in eighteen cases. Three presented teeth poorly kept; one had no teeth; three mouths were negative, and fifteen cases showed no record of an examination of the teeth having been made.

Further inspection of the respiratory tract revealed that five cases showed infected tonsils or nose; seventeen were negative for pathology and eighteen showed no record had been made of an examination of the nose and throat.

It was interesting to note that the examiners felt that the glandular system was of little significance, for of the forty cases, thirty were not examined for glandular involvement; four cases showed epitrochlear enlargement (one of these having cervical enlargement); in five cases the glands were not palpable and the glands of one case were reported as not enlarged.

The radiographic study of these cases was exceedingly interesting and instructive. If my interpretation of these cases is correct, one would not expect the films to show bone lesions which would influence largely these lumbo-sacral strains. The analysis shows that the fifth lumbar transverse process was enlarged or elongated in twelve instances, and, in my opinion, does not represent a pathological lesion. (Of these enlarged transverse processes four cases also showed hypertrophic arthritis). Ten cases showed no record of an x-ray having been made. Nine cases were reported negative for any bone change. Four films were interpreted as sacro-iliac separation, which appeals to me as incorrect, in that we have no standard by which we can judge

such a condition except in extremes with commensurate symptoms, and in addition no symptoms were referable to the sacro-iliac joint. Five cases showed an hypertrophic arthritis of the hip joint, acetabulum and spine.

A record of the venereal infections shows us that three cases admit the occurrence of a chancre alone; four cases a chancre and Neisserian infection. Seven acknowledge Neisserian infection alone and one of these states his wife has had six miscarriages. Twenty-two cases bear no record of the venereal history having been inquired into, two giving negative history.

Wassermann examination of the blood reveals the fact that eighteen gave negative reactions, ten positive reactions, ten were unrecorded and two were anti-complementary. No additional laboratory tests were done to determine the presence of lues.

As soon as radiographic examination and laboratory tests have been made it has been customary in this clinic to bring about a moderate degree of fixation of the lumbo-sacral joint by means of adhesive plaster strapping across the posterior aspect of the pelvis and obliquely up and down the spine, thus joining as one unit the pelvis and the lumbar spine. As a rule when disease processes are found such as lues, necrotic teeth, etc., no strapping is applied unless no relief is obtained after removal of the infective process. Later, when this temporary fixation of the spine has served its purpose, a permanent support is supplied in the form of a well-fitting corset in the case of women and a wide webbing belt in the case of men. In those very stubborn cases a plaster-of-Paris jacket is resorted to. Of the forty cases reported, twenty-four received adhesive plaster strapping; three were corseted immediately; one was put in a plaster jacket and twelve received no fixation.

The treatment given these cases consisted mainly in clearing up infectious foci, administering mixed treatment for those having a positive Wassermann or who were otherwise suspected of having lues, and in giving occasional doses of aspirin and atophan. In many cases no other treatment was required than fixation of the spine. In this series of cases nine belts were given; one corset; nine had necrotic teeth removed; fourteen received mixed treatment, or salvarsan, or both; one had the tonsils removed; one the nose operated upon, and two received aspirin and atophan. In some instances one patient received more than one of the enumerated therapeutic aids.

The results of the treatment were indicative of the proper diagnosis

Sex	*Onset*	*Location of Pain*	*Spinal Motion*	*Teeth*	*E. N. & Throat*
M	Sudden onset while lifting	Lumbo-sacral region	Slightly limited—spasm of back muscles	Pyorrhea	Tonsils infected
F	Sudden onset while stooping	Lumbo-sacral region	Muscle restricted	Crown and fillings	Tonsils infected
M	Sudden onset while stooping	Lumbo-sacral region	Very much restricted	Poorly kept	Negative
F	Sudden onset while stooping	Lumbo-sacral and right loin	Not recorded	Necrotic roots	Nasal discharge
M	Sudden onset while stooping	Lumbo-sacral region	Free and painless	Not recorded	Not recorded
F	Insidious for two years	Lumbo-sacral region	Free and painless	Necrotic roots	Negative
M	Sudden—fall in pit	Left hip, thigh and calf	Very limited muscle spasm	Necrotic roots	Negative
M	Insidious for several years	Lumbo-sacral, left thigh and leg	Very rigid spine	No record	No record
M	Insidious for years	Lumbo-sacral region	List to the left and marked limitation. (Sciatic scoliosis)	No record	No record
M	Insidious for years	Left 5th trans. process and loin	Very much limited	Very necrotic	Negative
M	Sudden—stooping	Lumbo-sacral region	Entirely rigid	None	Negative
M	Sudden—stooping	Lumbo-sacral region	Sciatic scoliosis—rigid	Negative	Negative
M	Sudden—not stooping	Lumbo-sacral region, rt. iliac crest and right abdomen	Marked limitation	Necrotic	No record
F	Insidious for 2 months	Lumbo-sacral region	Free and painless	No record	No record
M	Sudden—after stooping	Lumbo-sacral and rt. lower abdomen	Moderately restricted	No record	No record
M	Sudden—while lifting	Lumbo-sacral	Moderately restricted	Necrotic roots	Negative
F	Insidious—3 years	Sacral	Free—pain on pressure—sacro-iliac	No record	No record
M	Sudden—heavy lifting	Rt. lumbo-sacral angle	Muscle spasm—lumbar	Necrotic	Negative
M	Insidious—3 years	Lumbo-sacral	Moderately restricted	No record	No record
M	Sudden—while lifting	Left lumbo-sacral angle	Very rigid with muscle spasm—"Sciatic scoliosis"	Very necrotic	Negative
M	Insidious for 10 years	Lumbo-sacral region	Free and painless—bad posture	Necrotic	Lues of nose (?)

F	Insidious for 10 years	Lumbo-sacral region	Very rigid	No record	No record
M	Sudden—while lifting	Lumbo-sacral region	Free and painless	No record	No record
M	Sudden—while lifting	Lumbo-sacral and left loin	Moderately limited and painful	Very necrotic	Negative
M	Sudden—while lifting	Both loins	Free and painless	Very necrotic	Negative
M	Sudden—fall 6 years ago	Lumbo-sacral region	Rigid and painful	Very necrotic	Negative
M	Sudden—while lifting	Lumbo-sacral region	Very rigid and painful—"Sciatic scoliosis"	Very necrotic	Negative
M	Sudden—while twisting	Lumbo-sacral region	Free and painless	Very necrotic	No record
M	Insidious—at night	Lumbar and dorsal region	Slight restriction	No record	No record
M	Insidious—10 years	Lumbo-sacral and abdomen	Very rigid—"Sciatic scoliosis"	Very necrotic	No record
M	Insidious—2 weeks	Lumbo-sacral	Marked restriction	No record	No record
M	Sudden—while lifting	Left hip and leg	Very rigid—muscle spasm	No record	No record
M	Insidious—5 months	Rt. lumbo-sacral angle	Very rigid	No record	No record
M	Insidious—3 years	Lumbo-sacral and both hips	Free and painless	No record	No record
M	Insidious—2 months	Lumbo-sacral	Moderate restriction—"Sciatic scoliosis"	Negative	Infected
M	Insidious since Influenza	Lumbo-sacral	Very much restricted	Poorly kept	Negative
M	Insidious—3 years	Rt. lumbo-sacral angle, rt. hip and thigh	Very rigid—"Sciatic scoliosis"	Very necrotic	Negative
M	Sudden—heavy work	Lumbo-sacral, left thigh and leg	Moderately restricted	Negative	Negative
M	Insidious—14 years	Lumbo-sacral	Moderately restricted	Poorly kept	Negative
M	Sudden—fall	Lumbo-sacral		No record	No record

Glands	*X-Ray*	*Venereal Hist.*	*Blood Wasser.*	*Fixation*	*Medication and Treatment*	*Result*
Not recorded	5th lu. transverse pro. impinges	Chancre	Neg.	Trans-adhesive strapping	None—belt	Complete relief
Epitroch. marked enlarg.	None	1 miscg.	Positive	Corset of good type	Mixed treatment	Complete relief
Not palpable	Enlarged 5th lum. tran. pro.	No record	Positive	None	Mixed treatment	Complete relief
Not recorded	Neg. for bone change	No record	Positive	None	Mixed treat.—606	Complete relief
Not recorded	Enlarged 5th lum. tran. pro.	Not recorded	Positive	None	Mixed treatment	Complete relief
Not enlarged	Sacro-iliac separation	No record	Positive	None	Mixed treatment	Complete relief
Not recorded	Overgrowth left acetabulum	No record	Positive	None	Removal of necrotic teeth—mixed tr.	Complete relief
No record	Hypertrophic arth.	No record	No record	Adhesive plaster	None	Complete relief
No record	Hypertrophic arth.	No record	No record	Adhesive plaster	Belt	Complete relief
No record	None	No record	Negative	Adhesive plaster	Removal of necrotic teeth	Complete relief
Epitroch. enlarg.	None	No record	None	Adhesive strapping	Mixed treatment	Complete relief
No record	Neg. for bone change	Chancre	Positive	None	Mixed treat.—606.	Complete relief
Epitroch. palpable	Hypertrophic arth. large 5th lum. tran. pro.	No record	Anti-comp.	Adhesive plaster	Removal of necrotic teeth	No return. Considered relieved
No record	Neg. for bone change	No record	Positive	Corset at intervals	Mixed treatment	Complete relief
No record	Hypertrophic arth. 5th lum. tran. pro. enl.	Negative	None	Adhesive plaster	None	Complete relief
No record	Neg. for bone change	Neisser inf—no sore	Positive	None	Mixed treatment	Complete relief
No record	Neg. for bone change	No record	Negative	Corset	None	No further complaint
No record	No record	No record	Negative	None	Removal of necrotic teeth	Complete relief
No record	Large 5th lum. trans. pro. Sacro-iliac sepa.	Neisser—no sore	Negative	Adhesive strapping —belt (webbing)	None	Complete relief
No record	Neg. for bone change	Neisser—sore	Anti-comp.	Adhesive plaster	None	Last report—improved
Not recorded	Hypertrophic arth. hip, spine	No record	Negative	Adhesive plaster—corset	Op. nose, teeth removed	Marked relief

No record	Sacro-iliac separation	No record	No record	Adhesive plaster	Corset—webbing straps	No further pain
No record	No record	Neisser—chancre	No record	None	Acute sprain	No further pain
No record	No record	No record	Negative	Adhesive plaster	Removal of necrotic teeth	No further pain
No record	Impinging 5th trans. pro.	Neisser	Negative	None	Webbing belt	No further pain
Not palpable	Neg. for bone change	Neisser	Negative	Adhesive plaster	Removal of necrotic teeth	No further pain
Not palpable	Negative	Neisser	Negative	Adhesive plaster	Webbing belt	Some pain continues
No record	Hypertrophic arth. enl. 5th tran. pro.	No record	Positive	None	Removal of necrotic teeth	No further report
No record	No record	No record	No record	None	Mixed treatment	No further pain
Not palpable	No record	Neisser	No record	Adhesive plaster	Removal of necrotic teeth	No further pain
No record	No record	No record	No record	Adhesive plaster	Webbing belt	No further pain
No record	Hyper. arth. Sacro-il. sepa. Large 5th tran. pro.	Neisser—sore	Negative	Adhesive plaster	Webbing belt	Marked relief
No record	No record	No record	Negative	Adhesive plaster	Mixed treatment	No further pain
No record	Marked hypertrophic arthritis	Neisser—sore	Negative	Adhesive plaster	Aspirin, belt	No further pain
No record	Sacro-iliac separation	Neisser—wife 6 miscgs.	Negative	Adhesive plaster	Tonsils removed	No further pain
Cerv. and epitroch. palpable	Enlarged 5th lum. tran. pro.	No record	No record	Adhesive plaster	Mixed treatment	Marked relief
No record	Enlarged 5th tran. pro.	Sore	Negative	Adhesive plaster	Atophan—necrotic roots removed	Some improvement
No record	Enlarged 5th tran. pro.	Negative	Negative	Adhesive plaster	Atophan—webbing belt	Marked relief
Not palpable	Marked hypertrophic arthritis	No record	Negative	Plaster jacket	Mixed treatment	Slight relief
No record	Negative				Jacket for 60 days	Little relief

of lumbo-sacral strain, without bone changes involved in the pathology, as the relief was prompt, and as far as I can ascertain, was lasting. The duration of treatment averaged about three weeks. Had a bony structure been involved, or a large joint been sprained, the relief could not have been so prompt, nor could it have been effected in such a short time. The record of these forty cases shows that twenty-eight reported complete relief; six were markedly improved; four received only slight relief, and two failed to report their condition.

CONCLUSIONS.

1. That the major portion of the cases of low back pain seen in the Orthopedic Clinic of the Touro Infirmary are believed to be sprains of the lumbo-sacral ligaments, with many superimposed intercurrent infections, including lues.

2. That the location of pain is definitely assigned by the sufferers to the lumbo-sacral joint or the lumbo-sacral angles, and not in the neighborhood of the sacro-iliac joint.

3. That no examiner does his full duty to his patient nor can he arrive at an accurate diagnosis unless a careful and complete examination is done (possibly excluding the heart and lungs), especially in reference to infectious foci. And further, that he insist upon these foci being cleared up.

4. That too much dependence is put upon the x-ray as an aid to diagnosis. It is most useful in determining fractures and real dislocations in and around the low spine, but that bony anomalies and so-called sacro-iliac separation shown should not be interpreted as the cause for the low back pain, especially in cases of sudden onset.

5. That a venereal history and investigation are of great importance in both sexes.

6. That adhesive plaster strapping when applied promptly and firmly to the entire spine gives early relief, but should be supplemented with some form of permanent fixation for a short period after the temporary fixation has been removed.

SUBSTITUTING FELT FOR STEEL ARCH SUPPORTS.

BY WALTER G. ELMER, M.D., PHILADELPHIA.

A FEW years ago we were so accustomed to use steel arch supports to relieve foot strain that it seemed most unlikely that we would ever be induced to give them up altogether. But we have such a good substitute which has certain advantages over steel, that I find I have gotten away from the use of steel and am using felt altogether. It is more comfortable for the patient and is much easier to handle.

At one time I made a plaster-of-Paris model of the patient's foot—the foot being held by the patient as much in supination as possible, and the plaster model was sent to the instrument-maker, and by the aid of this he fashioned the steel arch. The method was satisfactory, as a rule, although it usually required some time for the patient to become accustomed to the rigid support upon which he was walking.

Gradually, we have gotten more and more accustomed to using felt. The foot soon adapts itself to the pad and, if necessary, the shape and position of the pad can be easily changed to meet the conditions. Piano felt is used. It is compact and firm and does not lose its shape, and it does not, as a rule, flatten down under prolonged use. Perhaps it would be worth while to outline briefly the method which I usually follow in the examination and treatment of the patients that come to my out-patient clinic complaining of various foot conditions, and indicate the extent to which felt is used in affording relief to the patient.

A typical case is that of a young woman who is earning her living and is obliged to be on her feet all day. She complains of pain in one or both feet. Probably it has been several weeks or months since she first began to suffer. The aching pain increases during the latter part of the day, and she returns home from her work tired out—anxious to get off her shoes and to get to bed early. When she first gets up in the morning her feet are stiff and painful. She is lame in walking about her room, but after moving about a little the pain and stiffness grow less and may disappear altogether, but later in the day the sense of fatigue comes on, then the dull, aching pain returns and grows worse towards night. She has probably been treated for rheumatism, but the symptoms continue and gradually grow worse until she may be obliged to give up her work.

Examination of the patient usually shows that she turns her feet far out in walking. The line of weight-bearing falls to the inner side of the foot, causing an overhanging inner malleolus; the inner border of the foot is slightly convex; the anterior portion of the foot may be moderately abducted upon the posterior portion; there probably is a fair longitudinal arch, although it is probably lower than it should be, and there may or may not be a hallux valgus. The position is one which is characteristic of foot strain or a weak foot. There is apt to be tenderness along the under and inner aspect of the scaphoid bone, also under the external malleolus, and the heads of one or more of the metatarsal bones may be tender. Uusually there is very fair mobility of the foot, although dorsal flexion is apt to be limited. The tendons of the peroneus longus and brevis muscles may be unduly tense, due to spasm or contracture in these muscles, and this may prevent the foot from being brought into correct position under the leg for weight-bearing. There are also cases where the calf muscles are contracted, preventing the foot from being brought easily to a right angle and into the correct line under the leg. The patient usually complains of pain through the instep, and it radiates up the leg to the knee. Sometimes it starts in the ball of the foot, and is sharp and lancinating—characteristic of metatarsalgia. There may be painful calluses under the ball of the foot, under the ball of the little toe, under the great toe, and also troublesome corns.

If we examine the shoe we find it is much narrower than the foot, pointed toe and high French heel. A correct shoe is the first requisite.

I have the patient stand upon a piece of paper and make an outline tracing of the foot and on this diagram draw a line across the ball and write upon it the width in inches. The patient is instructed to purchase a shoe which is not more than ¼ of an inch narrower than her foot. The shoe should be about one inch longer than her foot and have a medium rounded toe. The inner border of the shoe should be straight, permitting the great toe to lie in a straight line with the first metatarsal bone. There should be a square or a Thomas heel about 1¼ inches high and the shoes should have rigid shanks built into them.

The weight is transferred to the outer side of the foot, and the correct line of weight-bearing restored by the sloping sole and heel, the lift of leather being one-eighth inch or three-sixteenths of an inch along the inner margin. The hollow of the foot is supported by a felt pad which rises up along the inner side and slopes off to a thin edge at its outer side.

In cases of metatarsalgia, which is often associated with weak-foot and flat-foot, the pad is extended forward to support the metatarsal arch as well as the longitudinal arch. The ball of the great toe rests upon the sole of the shoe, as does that of the little toe also, but the felt, as it crosses the shoe just back of the ball of the foot, is raised in the centre to support the neck of the second, third, and fourth metatarsal bones. This maintains the bones in their normal relationship, relieves the heads from pressure and prevents the pinching of a nerve between them. It seems to me that our results are better when we use the sloping sole and heel, forcing the patient to bear his weight more on the outer side of his foot throughout its entire length, than when we use the sloping heel only. The wedge in the heel, however, may be a little greater than that in the sole. The fact that the width of the heel is less than the width of the sole means that the heel is given a more decided slope than the sole if we use a wedge of the same thickness in both. In adults three-sixteenths of an inch is the routine thickness. Sometimes only one-eighth inch is used, and occasionally one-fourth inch. Very rarely is as much of a tilt as one-third inch required.

I usually order a man's shoe the same width as his foot and about one inch longer than his foot. Men do not object to a shoe of the proper size and shape. But women, as a rule, do. It is surprising the extent to which women will go, and the amount of suffering they will put up with in order to wear what they consider good-looking and fashionable shoes. This is partly the fault of the woman herself and partly the shoe-dealers. The object of the latter seems to be to please and flatter their customers, and many of the dealers tell their customers that the shoe must be tight enough to support the foot. Here is a case in point. A woman came into my dispensary because she suffered from her feet. She limped painfully when she attempted to walk and could walk only a short distance. She had taken her troubles to one of our large department stores and finally found herself in charge of the woman who was at the head of the shoe department. This woman had discovered that her customer was suffering from "fallen arches and what she needed was a shoe that would support the foot." So the patient was provided with a pair of low shoes, French heels two and three-fourths inches high, sharp pointed toes. I made an outline tracing of this patient's foot while she was standing. It measured four and one-fourth inches across the ball. The sole of the shoe was two and seven-eighth inches at its widest part. The length of the shoe was less than the length of the foot. This was the shoe that was intended to support

the arch. When the patient was provided with the shoe which her foot required, sloping soles and heels and a felt pad under the hollow of the foot, she was able to walk as far as she liked in comfort.

The patients object at first to the size and shape of the shoes, but when they realize the comfort they obtain from them and the extent to which their symptoms rapidly disappear, they become reconciled to the change and are not anxious to return to the fashionable models. And where there were painful corns and calluses the results are equally satisfactory, as these entirely disappear in about three months and the skin of the foot becomes smooth and soft.

In those cases of flat-foot due to spasmodic contraction of the peroneus longus and brevis muscles, the correct position of the foot cannot be maintained until the cause is removed. A resection of one-half inch or three-fourths of an inch of the tendons of the peroneus longus and brevis muscles above the malleolus permits the foot to be brought easily into an overcorrected position and immobilized in plaster of Paris for four weeks. It can then be kept in the correct line by the special shoes with sloping sole and heel and a felt pad under the instep. It is sometimes necessary to lengthen the Achilles tendon, and I prefer to do this by a plastic operation rather than by a simple subcutaneous tenotomy.

In cases of rigid flat-foot it is necessary to restore the foot as nearly as possible to the normal contour by operation. It is usually necessary to divide the peroneus longus and brevis tendons. The foot is then forcibly corrected over the König block, the arch restored and the foot brought around into supination as much as possible and fixed in plaster of Paris from the toes to just below the knee. The patient is permitted to use crutches, his weight falling on the outer borders of his feet, and the casts are worn for six weeks. When they are removed the special shoes are put on. These have a lift of one-fourth of an inch along the inner margin and a felt pad under the instep. The patient should not be permitted to put his foot on the ground without this support unless he is voluntarily able to hold his feet in the corrected position and walk on the outer edges of them.

Patients suffering from painful and tender heels which are not due to spurs on the os calcis can often be very much relieved by making a hollow in the heel of the shoe and placing in this a soft cushion heel pad of rubber. A felt pad is placed under the hollow of the foot to receive the weight and relieve a considerable part of the weight-bearing from the heel.

This outline gives briefly the extent to which felt can be used instead of steel. The various foot conditions can be met in a satisfactory way without using any form of steel arch support, either for the longitudinal arch or the metatarsal arch, and it does not seem necessary to use the Thomas heel or the anterior heel. And it should be kept in mind that it is the shift back to the normal line of weight-bearing and the properly placed felt pad which relieves the foot from strain, and not forcing the foot into a shoe which is too small in order to gain support for the foot. The foot requires free play for the action of its muscles and should not be put into a shoe which restricts muscle action.

The family physician not infrequently refers his foot cases to an orthopædic instrument-maker and expects him to make the diagnosis and carry out the treatment. This, naturally, results in many mistakes. A rather striking example of this is the following:

A woman had been referred by her doctor to a firm in New York whose specialty was to make shoes to order for persons who had pain in their feet. Plaster-of-Paris models were made of the patient's feet and from these a pair of shoes was made. No instructions had been sent by the doctor. The price of the shoes was $136.00. The patient still had pain, and believing the shoes were not right, ordered a second pair. As it was not necessary to make the plaster casts over again, these shoes were $36.00. The result was no better and the patient told me that she had nine pairs of shoes made. Each pair was $36.00 except the last ones, which she had on when she came to my office, and those were $40.00. The case was a typical one of painful metatarsalgia. No diagnosis had been made of the condition and consequently no effort had been made to correct it. The shoes were far too narrow. I ordered a ready-made shoe of the proper size and shape, sloping soles and heels, rigid shanks and felt pads to support the hollow of the foot and extended forward to support the metatarsal arch also. The patient had immediate and complete relief from her symptoms and could walk in comfort. According to her statement she had paid $428.00 for shoes which had to be discarded.

Patients are always taught to walk with their feet parallel.

News Notes

Clinical Orthopedic Society.

The Central States Orthopedic Club, which has been very successful in arousing interest in orthopædic surgery throughout the Middle West, has reorganized under the name of the Clinical Orthopedic Society, a step in large measure due to the efforts of the retiring president, Dr. M. S. Henderson.

From its conception nine years ago, the Club has been entirely clinical, no papers being presented, and as the organization has long since passed the club stage, the new name has been taken as more indicative of the aims and aspirations of the Society.

The last meeting, according to the custom of visiting two centers a night's ride or less apart, was held in Iowa City, November 11, 1921, and in Kansas City, November 12, 1921. Dr. F. C. Kidner, of Detroit, has been elected President for the coming year, and the next meeting will be held in the Twin Cities and in Rochester, probably in October.

We Take from the "Gazzetta Ufficiale" of the 20th of January, 1922, No. 16, Istituto Ortopedico Rizzoli-Bologna, the Following Announcement:

Referring to article 15 of the statute for the Umberto I Prize, for which the competition opened on the 1st of January, 1920, and closed on th 31st of December of the same year, we publish the award for the assignment of the prize submitted by the Commission, composed of the Prof. Sen. F. Novaro, R. Dalla Vedova and V. Putti.

The Commissaires have agreed and concluded "that the prize must be assigned by merit to Dr. Murk Jansen, of Leyden, for the work presented for the competition.

Il Commissario Prefettizio,
G. Bellini.

Bologna, 24 January, 1922.

At the invitation of St. John's University, Shanghai, The Shantung Christian University Hospital, Tsinan, and the Pekin Union Medical College, Dr. E. G. Brackett of Boston has recently gone to China for three months to conduct a course of instruction to further the development of orthopædic surgery in the Orient. The hospitals have arranged to turn over to Dr. Brackett the facilities of their wards, so that in addition to didactic lectures, there will be practical bedside instruction and operative work in orthopædic conditions.

Current Orthopaedic Literature

TUBERCULOSIS.

EXTRA-ARTICULAR TUBERCULOSIS OF THE PATELLA. G. Jean. *Revue d'Orthopédie*, September, 1921, p. 393.

Two cases are reported.

1. Man of 44. Injury to right patella by direct violence in July, 1917, followed by rather sharp pain which persisted for several days. January, 1918, same pain recurred and was accompanied by swelling. A month later a definite tumefaction appeared, without fever. This was incised and some bloody pus evacuated. Fistulas persisted at each incision on either side of the patella. In July, 1919, the roentgenogram showing a point of rarefaction in the patella and the Wasserman being negative, two fairly long incisions were made on either side and a cavity on the posterior surface curetted out. Under heliotherapy without immobilization the wounds were healed and the patient was well by October, 1919.

2. Man of 21. Pain over the left patella appeared spontaneously. A tumefaction occurred and was treated in the same manner as the preceding case. Three months after operation the patient had entirely recovered under heliotherapy without immobilization.

There was little or no functional disturbance of the knee in either of these cases.

There are about a hundred cases of primary tuberculosis of the patella found in the literature since 1888. Due to change in structure of the patella with age, the lesion occurs in the anterior part in children and the posterior part in adults. The joint is not involved because the point of the patella where the lesion occurs is in relation to the fat pad and is thus extra-articular. This localization of the disease is regarded by Mayet as analogous to tubercular epiphysitis. It is thought that exposure of this part of the patella to trauma predisposes to the lesion. Surgical intervention is the treatment of choice, and cure is relatively rapid. The rarefied portion of the bone should be thoroughly removed, care being taken not to go through into the synovial membrane.—*William Arthur Clark, Pasadena, Calif.*

A VARIETY OF TUBERCULOUS COXALGIA IN THE ADULT: DRY CARIES OF THE HIP. Maurice Patel. *Revue d'Orthopédie*, September, 1921, p. 385.

For a long time (since Wolkmann) a special form of tubercular osteoarthritis has been recognized under the name of dry caries. It has been described in the shoulder, hip, wrist, and elbow. Rottenstein and Houzel (1910), in reporting two such cases of the hip, stated that they found, among lesions going under the names of osteoarthritis deformans juvenilis and monarticular tubercular rheumatism, a certain number of cases which they con-

sidered as dry caries. It is characterized by an eburnation of the femoral head without fungosity or joint effusion.

The author reports a case of a woman of 52 who began to have rather violent pain in the right hip, which after a month confined her to bed, unable to walk. She has been losing strength for a year. The hip was in abduction and external rotation and the pelvis was tilted toward the affected side. All movements limited and painful. Muscular atrophy of 3 cm. A diagnosis of tubercular hip was made at this time. After immobilization of fifteen months the patient walked with a cane, although motion was not normal and was still somewhat painful. The symptoms gradually subsided during the following year, but then she suddenly noticed a lack of support and the right hip seemed to dislocate at every step. Examination then revealed, practically, a flail hip with 3 cm. shortening. When weight was borne on the right leg the great trochanter went up into the iliac fossa. The roentgenogram four months later showed that the head and neck of the femur had disappeared and that the great trochanter was rarefied. The acetabulum was equally rarefied, but its depth and form were preserved. The patient refused operation and continued to walk with a brace and pelvic belt.

This case seems to have progressed in two periods: (1) a period of arthritis with pain, muscular atrophy, and impairment of function. (2) a period of bone destruction which began about the time the patient began to walk. The woman was known to be tubercular and there was no doubt that the hip lesion was due to this disease, although there was no joint effusion.—*William Arthur Clark, Pasadena, Calif.*

TRAUMATA.

OLD OS CALCIS FRACTURES. Fred J. Cotton, M.D. *Annals of Surgery*, Vol. 74, No. 3, September, 1921.

This article by Dr. Cotton is well worth consideration, as it deals with a condition that is of great importance, especially in industrial surgery. The author's suggestions are the result of much thought with reference to these old cases of continued disability following injury to the ankles. In early cases of ankle injury with fracture of the os calcis the author's well known method of remodeling is strongly advocated, even in the presence of impaction.

This article, however, deals with the old cases which have had a long period of disability, which have not responded to the various lines of procedure that are usually employed.

The pathology is evidenced by a thickening of the heel on the outer side, caused by impaction or callus production, the callus sometimes being so extensive that it impinges upon or surrounds the malleolus. This bony contact is the cause of the discomfort.

X-ray reveals this deformity when the exposure is made from behind and above, diagonally downward and forward through the heel, revealing the contour of the os calcis.

Dr. Cotton advocates evulsion of the excess of bone, clearing the inter-

ference with the outer ankle after the following manner: "Incision is made downward and forward beneath the external malleolus; stripping up and laying forward and upward of a flap, including the peroneal tendons in their sheath, turning up with them the periosteum and with it the cortical layer of the bone; then comes a thorough clearing away of all of the excess of bone, deep below the cortical level, leaving a saucer-like crater of bone. In doing this clearing away one cuts across the posterior astragalo-calcaneal joint regardless of the ligaments and capsule. Then, forced manipulation in rotation and in abduction and adduction of the foot complete the clearing of any obstacle to motion from the bone, from adhesions or from scar. At this stage, after reduction, motion should be near normal and unimpeded by adhesions or excess of bone. After clearing away the excess of bone the periosteal flap, carrying tendons, is laid down into the crater from which the excess bone has been removed. Loose suturing completes the operation. Plaster is applied in neutral position. Pressure is applied from outside to press the flap into position. After two weeks the bandage is removed and passive motion is begun. Weight bearing is allowed after six weeks, using caution. In some cases a Whitman support is used temporarily. The case should be kept under observation until maximum improvement is obtained."

The article is accompanied by a series of case reports that are indeed encouraging.—*A. G. Nichol, Nashville, Tenn.*

FRACTURE OF THE SCAPHOID OF THE FOOT. A. Rosenberg. *Deutsch. Zeitschrift f. Chir.*, 1921, Vol. 164, p. 394.

An extensive review of the heretofore reported cases of such fractures is outlined and the history and management of one of the author's own cases is added.

The mode of production of the scaphoid fractures is considered as follows: The individual falls from a height and lands on the feet; to minimize the force of impact, the feet are plantar flexed, endeavoring to alight on the toes; losing equilibrium, the person falls backward. During this backward fall, the scaphoid becomes compressed between the cuneiform anteriorly and the astragalus posteriorly, and breaks.

The author advocates the abolishment of operative treatment, such as nailing or extirpation, but bandages the foot in a corrected position of supination, and encourages standing and walking, notwithstanding the pain. Local heat and massage is applied to hasten recovery.—*A. Gottlieb, Los Angeles, Calif.*

FRACTURE OF THE NECK OF THE FEMUR. A report of Three Cases with Delayed but Successful Application of the Whitman Abduction Treatment. S. Kleinberg, *Medical Record*, January 7, 1922.

These cases are reported in detail and the results seem to justify the use of this method even several months after the original injury. Proper manipulation is believed by the author to be indispensable.—*Edward S. Hatch, New Orleans, La.*

CERTAIN PROBLEMS CONCERNING FRACTURES OF BONES. Charles M. Scudder, M.D. *Annals of Surgery*, Vol. 74, No. 3, September, 1921.

This is a review of the general methods now used in the treatment of long bone fractures, bringing out nothing especially new in technic, but strongly advocating a better understanding of the subject and a more efficient training of the individual surgeon in this line of endeavor.

There is a demand, especially on the part of the workingman and his employer, for greater skill and a shorter period of disability, and in this article the author endeavors to outline a method by which this improvement may be attained. This method is by organizing special fracture service in each of the larger hospitals of the country after the following fashion.

"(A) Special wards should be used for men, women, and children, and only fracture cases admitted. It is impossible to care adequately for these cases when they are scattered throughout the hospital. Responsibility is divided among many individuals. No concentrated interest results. Too much work is delegated to ignorant subordinates. The general service would be more free if separated from the fracture cases.

(B) A special fracture personnel should be in charge of fracture wards. There should be a chief of this service, a surgeon of broad general experience, whose interest should be active in moulding the policy of the fracture division. He alone should be finally responsible for results. Serving under him should be the necessary assistants, etc. This service should be continuous throughout the year.

(C) This service should be in continuous control of the Out-Patient Service, where ambulatory cases are received and treated. Each day of the week there should be an Out-Patient clinic for fractures, which the fracture service controls and with which it is in intimate touch. The policies of the Out-Patient and House Fracture Services should be identical under the Chief of the service. Cases of fracture should be followed until maximum functional results are obtained and until the wage-earner is on his feet and re-established again.

(D) The emergency ward or accident service, in so far as fractures are concerned, should likewise be under the care of the Chief of the Fracture Service. A fracture received into the accident ward should be regarded as an emergency case requiring the immediate attention of those who are directly responsible for the ultimate result. A fracture should be considered as much an emergency as is a case of perforated gastric ulcer. The initial treatment is vital to a satisfactory outcome in both instances.

(E) An operating plant in connection with the House Service is essential. The operative fractures must be kept apart from septic operations. Separate instruments must be employed."

Together with these recommendations are suggested lecture rooms where the subject can be adequately taught in a graduate school and to undergraduates, though to these latter only after they are well grounded in the fundamentals, and this instruction should be given in the third and fourth years.

The institution of smaller units in outlying centers and the liberal use of educational propaganda.

Encouraging specialization within general surgery of the surgery of fractures.

The author feels that there is ample room for a specialty of fracture and traumatic surgery in the larger communities, and that there should be ample demand for such a specialty.

During the war the orthopædic surgeon did efficient work in fractures and traumatic surgery, and as the result there is a question that is being forced upon Staffs of Hospitals, "Shall fractures of bones and traumatic surgery be delegated to the members of the orthopædic staff of our hospitals?" There is opposition to this course, based largely upon the fact that many capable men who are doing efficient orthopædic surgery are not qualified as general surgeons, and for this reason it is believed that the general surgeon is more capable of caring for this type of work.

The author states that "The door to special surgical work should always be through general surgery" and believes that the time is coming when young men will specialize in traumatic surgery, and considers the present scope of orthopædic surgery is sufficiently large to occupy the orthopædic surgeon. —*A. G. Nichol, Nashville, Tenn.*

INFLUENCE OF PHYSICAL THERAPY IN REDUCING TIME OF DISABILITY IN FRACTURES OF THE LONG BONES. Jonathan M. Wainwright, M.D. *Annals of Surgery*, Vol. 74, No. 3, September, 1921.

This is a short article advocating the early use of physical therapy in fractures of the long bones and accompanied by a table of comparative results, showing an improvement of from twelve to twenty-eight per cent., resulting from this adjunct to the usual methods of treating such fractures. There is no especial technic mentioned.—*A. G. Nichol, Nashville, Tenn.*

NOTE ON THE INJURIES TO THE SEMILUNAR CARTILAGE OF THE KNEE. With Special Reference to Industrial Accidents. James Eaves and Paul Campiche. *Medical Record*, December 24, 1921.

This paper takes up the subject as it interests surgeons having the care of industrial accidents, and stresses the two points: "When Should We Operate?" and "What Character of Operative Procedure Should be Followed?" The writers feel that many patients get well without operation, but as they often see patients after alleged "reduction" when the patients are still suffering, they feel that after a period of six weeks, operation by the method of Sir Robert Jones should be done. Excision should be as complete as possible. —*Edward S. Hatch, New Orleans, La.*

PARALYSIS.

TREATMENT OF NEGLECTED CASES OF CLUB-FOOT. A. Paynter Noall. *British Medical Journal*, December 31, 1921.

Under this title the author discusses paralytic equino-varus and calcaneo-valgus, also claw-foot. For the equino-varus he describes a technic of resection of the mid-tarsal joints with plantar fasciotomy and Achilles lengthening. If the tibialis anticus is acting strongly he also transfers its attachment to periosteum over the cuboid. The posterior ligament of the ankle joint is also divided. There is the usual after-treatment of plaster, varus brace and massage.

This same procedure is advised for the various types of claw-foot or pes cavus.

For calcaneo-cavus he employs the two-stage operation of Sir Robert Jones. Whitman's operation is not mentioned.

In extreme cases of paralysis he assumes that apparatus must be worn permanently after these operations.—*R. W. Billington, Nashville, Tenn.*

BIRTH PARALYSIS. H. Platt. *British Medical Journal*, November 26, 1921

The author believes that clinical, experimental and operative evidence are all in favor of the view that in most cases there is a supraclavicular lesion of the brachial plexus. In the majority of such cases the nerve lesion is of the incomplete anatomical type and is followed by unhindered spontaneous regeneration. A few cases may be due to injury to shoulder joint capsule and secondary involvement of certain branches of the brachial plexus.

Considerable spontaneous recovery usually occurs in a few weeks or months. Whether the nerve recovery be complete or incomplete there usually remains more or less contracture and subluxation of the shoulder joint which become more marked with time and growth, but which can be prevented by proper early treatment consisting of correct posture and physical therapy. He does not approve of operation on the plexus before nine months of age and not then unless there is still complete paralysis and marked atrophy indicating no recovery. He thinks it of doubtful value in any case.

Contractures and subluxations of the shoulder are corrected by stretching and continued posture of overcorrection, cases over two years old usually requiring open division of contracted tissues as done by Sever, of Boston. He thinks that in most untreated cases the deformity is not due to failure of nerve regeneration, but is mechanical or postural. In his thirty-four cases, the paralysis recovered in twenty-nine. In six old cases with residual paralysis in the lower arm four showed recovery after prolonged splinting in the relaxed posture. In the other two cases tendon transplantation was performed.—*R. W. Billington, Nashville, Tenn.*

NEOPLASMS.

ACTION OF RADIUM ON TUMORS OF THE BONE. With Report of Two Cases. Isaac Levin. *Medical Record*, Vol. 100, No. 10, October 15, 1921.

The author reports a case of carcinoma of the breast with metastasis in the humerus and pathological fracture. An x-ray showed complete destruction of the bone for over an inch. The fracture was treated with three packs of tubes of radium emanations, one pack on the anterior surface, the others on the external and internal surfaces of the arm. In all 208.9 millicuries of radium emanations were applied for sixteen hours. This treatment was repeated in a week, using 249.1 millicuries for the same time. Two weeks after the first application an x-ray showed callus and the patient was able to support her arm without splints.

In the second case the patient had a tumor in the region of the upper third of the tibia. The x-ray showed a defect in the bone about two inches long and one inch wide. On operation it was found that the tumor had invaded the muscles, and on removal only a small shell of the outer wall of the tibia remained. A brass box with radium emanation tubes was placed in the cavity giving 213.0 millicuries for sixteen hours. This was followed by several applications of radium packs over the operative field. Twelve months later an x-ray showed the cavity filled with compact bone. The nature of the tumor was not stated.

The author believes that radium causes a very rapid formation of new bone. It seems feasible to suppose that radium therapy may hasten callus formation in fracture and increase the success of bone implantations. Multiple myeloma of the bone is more akin to lympho-sarcoma than to true sarcoma or carcinoma and must therefore be more radio-sensitive than the latter conditions. Chronic inflammatory diseases of the skeleton, osteitis or osteomyelitis present frequently pathological pictures similar to sarcomata of the bone. It is possible that if these were treated as in case two, satisfactory clinical results might be obtained.—*A. O'Reilly, St. Louis, Mo.*

GANGLION OF THE WRIST REGION. WITH REPORT OF TWO CASES SHOWING DESTRUCTIVE TENDON INVOLVEMENT. H. P. H. Galloway. *Canadian Medical Association Journal*, October, 1921.

The two varieties of swelling in the wrist region to which the name "ganglion" is attached, are described and differentiated, the tuberculous nature of the compound diffuse ganglion being emphasized.

The treatment recommended for both conditions is extirpation by careful dissection. In the case of the tuberculous lesion this predicates a minute knowledge of the anatomy of the region, and patience to undertake a painstaking operation of possibly two hours in length. The advantages of a bloodless field are evident, and to diminish the chance of Esmarch paralysis, the use of two tourniquets of rubber tubing is recommended, one applied above the

elbow, the other below, each for approximately one-half of the time of operation.

While the tendons themselves usually escape destruction they are not infrequently involved in long-standing cases, and thorough removal of the disease necessitates the sacrifice of tendons where these are extensively involved. The recovery of function is usually surprisingly good. It is assisted by gentle passive movement from the third day onwards, and radiant heat, massage, and systematic exercises after healing is complete. Two cases are quoted. In both the long flexor tendon of the thumb was sacrificed and in one of these the tendons of the flexor sublimis also suffered. In both "the functional result was excellent."—*Alexander Gibson, Winnipeg, Manitoba.*

METABOLIC DISTURBANCES.

TREATMENT OF RAYNAUD'S DISEASE WITH THYROID EXTRACT. Edwin W. Hirsch. *Medical Record*, January 7, 1922.

A general outline of Raynaud's disease is given, in which history, pathology, symptoms, and diagnosis are taken up. One case is reported in which the use of thyroid extract gave marked relief.—*Edward S. Hatch, New Orleans, La.*

FRAGILITIS OSSIUM. Edgar A. Vander Veer, M.D., and Arthur M. Dickinson, M.D. *Annals of Surgery*, November, 1921.

"In all the case reports reviewed there was no reference to an abnormal condition of the teeth. Practically all referred to the teeth as negative or in good condition. In the case we are reporting, the child has a very interesting condition of the teeth. They are almost all translucent and show every evidence of lack of mineral salts. The mother informed one of us that the first teeth were the same and did not last any time at all, but were so fragile that they soon crumbled. The permanent teeth seemed much the same as the deciduous set in this regard."

Author reports a case in which a child had, in all, fourteen fractures. These were all located in the femur and mostly in the right one, a sudden turn or a sharp twist often being enough to cause a new one.

Conclusions:

1. Fragilitis ossium is a relatively rare condition and is accompanied by blue sclera.

2. The etiology is unknown in the large majority of cases, less than ten per cent. being on an hereditary basis.

3. There is no demonstrable relationship between fragilitis ossium and any other bone condition, as scurvy, tuberculosis, syphilis, osteomalacia, etc.

4. The treatment is very unsatisfactory and offers no hope of cure.—*Thomas Madden Foley, Washington, D.C.*

ETIOLOGY OF RICKETS. G. Bruton Sweet. *British Medical Journal*, December 24, 1921.

The various theories, old and new, of the causation of rickets are mentioned and his own observations of the disease in New Zealand, as compared with Great Britain, are interestingly discussed. His conclusions are: (1) That rickets is due to fat-soluble A vitamin has not been proven. (2) It is primarily due to a diet deficient in fresh animal food, probably suitable protein, or a disturbed digestive condition which prevents assimilation of same. (3) The striking metabolic changes are due secondarily to deficiency of secretion of one or more endocrine organs, probably chiefly of the thymus. (4) Confinement with attendant evils of lack of sunshine, exercise, and cleanliness are important factors in increasing the severity of the disease.—*R. W. Billington, Nashville, Tenn.*

OSTEOMYELITIS.

A CLINICAL STUDY OF THE PATHOLOGY OF OSTEOMYELITIS. A. Gibson. *Canadian Medical Association Journal*, November, 1921.

There are two distinct types of osteomyelitis, juvenile and adult; the first metaphyseal, the second may occur anywhere in the bone. Of forty-eight cases occurring in civil practice, the average age of onset was 17, the youngest 7½ months, the oldest 64 years. Of fifty-nine bones affected forty-four were in the lower limb.

In regard to etiology 24 cases showed no direct existing cause, while the remainder were the result of traceable local or systemic infection.

Ten cases showed recurrence in another bone of the body, after an interval generally reckoned in years. Five deaths are recorded in the series.

The different varieties of sequestra are considered, special note being made of the "lining" sequestrum, a thin tube of dead bone found in the shaft of long bones in three cases. Organisms may remain beleaguered in a bone abscess for an indefinite period, one case in the series showing an interval of thirty-eight years.

Summaries of the cases are given, and two cases are cited in detail to show the relentless manner in which a bone infection remains ready to break out. In the second of these cases, the first attack occurred in 1870 when the patient was 14 years of age. Attacks occurred at intervals, amputation being performed in 1908. Death occurred in 1920 from recrudescence in the stump.

HEMORRHAGIC OSTEOMYELITIS. Ernest H. Arnold. *Boston Medical and Surgical Journal*, December 8, 1921, p. 677.

Hemorrhagic osteomyelitis is apt to exist without symptoms, subjective or objective, and may go, therefore, unrecognized. If the lesion be situated near a joint, it may be mistaken for a joint lesion such as tuberculosis, or it

may be taken for a malignant bone tumor. Conservative treatment, as a brace, has no influence on hemorrhagic osteomyelitis. Radical interference is necessary.

Etiology. The lesion is not frequent, because it exists unrecognized and undiagnosed. Its preference for spongy bone explains its occurrence in childhood and youth. In the author's group of cases there was none older than twenty-five. History of trauma is frequently given.

Pathology. There is a cavity in the spongy part of a long bone, filled with a dark brownish mass of jelly-like material, into which uncoagulated blood oozes. A membrane, brownish red, lines the cavity. The cavity expands, driving the cortex before it. The microscopic picture is the following. The mass is found to be a hemorrhagic extravasation in which light-colored areas, consisting of young fibroblastic tissue, are noticed. In these are found many multinucleated giant cells of the foreign-body type of cell. This cyst formation and the presence of giant cells were undoubtedly responsible for the view held in many quarters, until quite recently, that the condition was one of tumor formation, bone cyst, of this being classed as giant-cell sarcoma. However, it is now recognized that the process is one of a low-grade inflammation, usually chronic in character, in response to trauma. The giant-cells have not a tumor-forming but a scavenger function.

Diagnostic Points. There are no general symptoms such as fever, anemia, or loss of weight. There may be no local symptoms. The lesion may be accidently discovered by x-ray or there may be a spontaneous fracture. Pain and the usual signs of inflammation may be late. There is no muscle spasm or atrophy. The process is of long duration and there are no exacerbations or metastases. Hemorrhagic osteomyelitis is to be differentiated from malignant bone tumor (sarcoma) and bone tuberculosis. These latter, however, are usually ruled out by x-ray.

Treatment. Curettage of hemorrhagic membrane and whole cavity and recesses; close without drainage. A protection splint is worn. X-ray pictures at frequent intervals control the recovery. The prognosis is good. The author discusses four cases, two in tibia, one in humerus, and one in femur. —*Voigt Mooney, Pittsburgh, Pa.*

MISCELLANEOUS.

SOME FACTORS IN BONE REPAIR. William Seaman Bainbridge. *Medical Record*, January 7, 1922.

This is a very interesting and timely paper in which the author points out at some length the causes other than local which interfere with the proper repair of fractured bones. He cites: (1) Blood; bacteriology, including lowered resistance of fractured bones; metastatic infection from concealed foci; constitutional diseases. (2) Blood chemistry. (3) Interference with the constructive metabolism of bone through injury to the nutrient artery.—*Edward S. Hatch, New Orleans, La.*

RHEUMATOID ARTHRITIS: LESSON OF TWENTY-FIVE YEARS' EXPERIENCE. N. Davies. *Practitioner*, December, 1921.

Results of observations and treatment of rheumatoid arthritis over a period of a quarter of a century at Llandrindal Wells and elsewhere.

If microbic theory were the originator of the mischief, treatment with autogenous vaccines would not be the failure it generally is. If good results followed the wholesale extraction of teeth, there would be nothing to be said; but they do not, except in rare cases.

Depressing surroundings, damp and cold, business and domestic worries, injuries or shock, are constant factors noticed.

Provided that the cartilages are not seriously damaged and that the affected joints are not contracted, and set at an angle which strains the skin, something can be done to check the onward course. Contracted knee-joints are hopeless and largely due to neglect to keep the limbs straight during sleeping hours.

Local treatment must be assisted by constitutional treatment. As the strength is at a low ebb, salicylates, hot packs, Turkish baths, etc., should not be used except in the early stages. Numbers of chronic cases return home from the Spas, disillusioned and helpless cripples. Massage, which has never done any good in these cases, fails because it creates heat, and uric acid flies to an inflamed and heated spot and is deposited there. An injured (heated) ankle acquired exudations and caused a stiff ankle (cites a case). In a milder form the same thing happens in men of uric acid diathesis who ride much (quotes personal experience). The fingers of the left hand, holding the reins, get rubbed (massaged) by the horse's mane, and the knuckles of the hand become hot and then the seat of deposits. It is significant that the right hand escapes.

Ionic medication has fallen into disrepute due to faulty application, but properly applied, in conjunction with constitutional measures, it is the only means of dealing satisfactorily with rheumatoid affections. This medication must be concentrated in the affected joint. Tr. of iodine and carbonate of lithia give better results than any other agents. In light cases a course of from three to nine treatments every three to twelve months is given. Even this remedy, effective as it is in the majority of cases, is of little use in cases in which the cartilage is eburnized and the bones ankylosed.

Author recommends, in cases which resist this form of treatment, in which there is great pain, the use of his test for neuritis and treatment by his method described in the *Practitioner* for June, 1914. Where rheumatoid arthritis is complicated with neuritis, always treat the latter first. Syr. of Hypophosphites and Summer's Elixir of formate of soda to be used for exhaustion and in place of salicylates. Non-uric acid diet recommended. Environment an important factor. Ionic medication should be supervised.—*Thomas Madden Foley, Washington, D.C.*

MOBILIZATION OF BONY ANKYLOSIS OF THE KNEE-JOINT—ARTHROPLASTY. Charles Ogilvy. *New York Medical Journal*, November 16, 1921.

The majority of attempts to mobilize ankylosed knee-joints have proved

unsatisfactory and disappointing because in one group re-ankyloses resulted and in the other group extreme lateral mobility from the loss of the crucials and the sacrifice of lateral ligaments.

Author quotes Albee's surgery for historical sketch and gives technique of operation and end-result in a case of complete bony ankylosis of the knee-joint, resulting in a "normal functionating joint."

"With a very thin half-inch wide chisel, curved on the flat, the new joint was chiseled, in as close approximation to the old one as could be judged. First the outer half of the joint was freed and then the inner. No bone was removed, as is advised by Putti, as this, in my opinion, tends in part to cause instability of the joint subsequently." Author smooths joint surfaces with a fine-bladed chisel and a large curette, strips away only enough of the lateral ligaments to permit flexion to a right angle, secures interposed fascia lata with its fat to the lateral ligaments by one stitch on each side.

Knee was lifted slightly out of extension cast in two weeks, weight bearing was allowed in one month, patient was able to walk without the aid of crutches two months after operation.—*Thomas Madden Foley, Washington, D.C.*

THE TREATMENT OF IRREPARABLE NERVE INJURIES. R. I. Harris. *Canadian Medical Association Journal*, November, 1921.

Experience has shown that end-to-end suture of a divided nerve is the ideal method of treatment. Failure to restore function has occurred in cases where suture was possible, owing to several causes: (1) the quantity of scar tissue following suppuration; (2) axial rotation of the fragments, whereby proximal sensory fibrils have been united to distal motor fibrils, and *vice versa;* (3) pulling apart at the site of suture from (a) too much tension, (b) imperfect or too brief fixation; (4) wrapping the junction in fat, etc.; (5) metaplastic bone.

All cases where separation of the suture is the source of failure should be submitted to re-suture. In cases where the ends cannot be co-apted, and where from other reasons the lesion is deemed irreparable, much can be done. The use of bridges and nerve transplants has been clinically a uniform failure. In the arm the results of tendon transplantation have been brilliant, notably so in musculospiral lesions. By transplanting pronator teres to the extensors of the wrist, flexor carpi radialis to the finger extensors, and palmaris longus to the thumb extensors, 100 per cent. of cases are improved, and the majority can resume occupation even where this involves arduous work.

In the case of the median nerve, the resulting anæsthesia is more important than the paralysis in low lesions, and attempts to overcome this by suturing the radial to the median have given promising results.

For the paralysis of a high median lesion some of the extensor muscles, such as brachio-radialis, or abductor pollicis longus, may be utilzed by attachment to flexor tendons. In ulnar lesions, no remedial measure, except amputation of an inconvenient digit is suggested.

In the lower limb stability is the desideratum, and tendon transference yields poor functional results. Stabilization operations on the foot are preferable when necessary. Complete sciatic paralysis usually entails less serious functional motor disability than does incomplete. For mal-positions due to imperfectly balanced muscle-pull, tendon fixations, *e.g.*, tibialis anterior to tibia and peroneals to fibula, have proved of service.—*Alexander Gibson, Winnipeg, Manitoba.*

ANATOMIC EVOLUTION OF THE HIP AFTER REDUCTION OF CONGENITAL LUXATIONS. Broca and d'Intignano. *Revue d'Orthopédie*, September, 1921, p. 353.

After reduction, the treatment of a congenital hip has for its end the reforming of the joint to make it functionally useful. The orientation of the femoral head is changed and the acetabulum deepened by maintaining the leg in the most favorable position. In later stages of treatment, walking aids in accomplishing this end.

The original malformation is characterized by general thinning of the bone, anteversion of the neck and arrested development of the head. On the part of the acetabulum there is a lack of depth and the iliac portion, instead of forming a roof, ascends obliquely.

During the period of immobilization the object, from a mechanical standpoint, is not only to deepen the acetabulum by direct pressure of the head, but to reshape the head and neck by making a pressure in a varus direction. In case the acetabulum is already deep enough, the thigh is placed in such a position (extreme abduction and external rotation) that the ligament of Bertin (Bigelow) is on tension so that it holds the head up against the roof of the acetabulum. Furthermore, the ligament of Bertin, thus placed on tension, elongates so that it is possible to adduct the femur without throwing the head out. When this elongation has occurred and when the posterior part of the capsule, originally relaxed, has contracted enough to furnish some support, the second step in treatment is taken. This is at about three months and consists in bringing the thigh down about one-third from the position of extreme abduction and external rotation and giving it a little internal rotation. The patient then begins to walk with the leg held in this position in apparatus, the head of the femur continuing to deepen the acetabulum.

The conditions are quite different when the roof of the acetabulum is replaced by an oblique or even almost vertical wall. Then the head, after being reduced, slips out with the slightest attempt at adduction. By immobilizing in acute flexion and forced abduction, a mediocre deepening of the acetabulum is effected, but the results are not good. Although complete reluxation is rare, ascension and separation of the head are not.

Sometimes the reconstitution of the joint is perfect and one is unable to tell which was the affected side, either by the patient's gait or by the roentgenogram. Among 357 cases studied, about a dozen came under this cat-

egory. Almost always an osseous deformity persists even though the functional result is not compromised. This is usually a varus position either of the head alone (115 cases) or with a varus also of the neck (158 cases). This varus may be a right angle or even less, but the head, nevertheless, remains in the acetabulum. A persistent valgus is fortunately more rare, since, although it is compatible with a good result, it predisposes to reluxation or, at least, to ascension and separation of the head. In 52 cases of this deformity a progressive reluxation occurred in only four and an elevation of the head in 32 cases.

The remodeling, under the influence of walking and ossification, brings about a hollowing of the acetabulum and a rounding off of the head. The aspect may become absolutely normal (about twelve cases in this series), but in most instances abnormalities persist.

What has been said above applies to cases a year or two after reduction. Fifty patients (72 luxations) were examined eight or ten years after reduction. In general, these cases show a tendency toward normal form under the influence of corrected function. The neck, which in the first stages of treatment was in a varus position, later takes a more normal direction. In 18 cases there was observed a re-formation of a neck in valgus with a flattened head, giving an excellent functional result. It has been noticed that the late or secondary reconstitution of the joint is much less in cases operated a little late, after four or five years for unilaterals and after five or six years for bilaterals.

In general, it may be said that it is quite exceptional to have a reluxation if the head has remained in after several months of walking. Regarding the influence of age, it is interesting to note that in young children with bilaterals, the side first operated gives a better modeled joint than the second side which is of necessity operated about a year later.

Sixty cases are reported in detail and there are 106 illustrations reproduced from roentgenograms. These illustrations are so closely followed in the text that an abstract falls short of doing full justice to the paper. The number of cases studied and the manner in which they are presented give to this article an unusually high value.—*William Arthur Clark, Pasadena, Calif.*

WRITERS' CRAMP—ITS CAUSE AND CURE. W. H. Bates. *Medical Record*, Vol. 100, No. 10, September 3, 1921.

The author, who is an ophthalmologist, reviews the various theories of the cause of writers' cramp. He states that his practice has brought him in contact with a number of such cases. He has found upon investigation that in these cases the patient has slept with the hand or arm under his head, and that when this practice was corrected the symptoms very quickly disappeared. He cites three cases and states that he has never known a case of occupational cramp that did not yield to this simple treatment.—*A. O'Reilly, St. Louis, Mo.*

OBSERVATIONS ON THE NORMALLY DEVELOPING SHOULDER. Isidore Cohn, M.D., F.A.C.S. *American Journal Roentgenology*, January, 1922.

The study has been divided into three parts:

1. A review of the literature.
2. Observations based on a study of normal shoulder joint.
3. Descriptive findings of individual radiograms of normal joints of various ages.

The summary explains nineteen of the twenty-two plates illustrating the radiograms.

Conclusions: Radiologic examination of the shoulder girdle during the first year shows only one epiphysis sufficiently ossified to leave a shadow, the epiphysis for the upper end of the humerus. This epiphysis is represented by a small elliptical shadow, which is rather widely separated from the upper end of the shaft. Our earliest observation was seven weeks.

During the first two years no other epiphysis makes its appearance, except for a small shadow which may be interpreted as the early ossification within the coracoid process.

During the third year the head of the humerus increases rather rapidly in size. The upper end of the shaft takes on the appearance of a double inclined plane, higher near the middle and sloping downward to either side.

At this time there is a shadow on the outer and lower aspect of the epiphysis for the head, which may be ossification within a separate epiphysis for the greater tuberosity or it may be that the greater tuberosity is a downward growth from the original epiphysis for the head. In the pictures no clear line of demarcation can be made out between the shadows.

Beginning ossification within the coracoid is evident at three years.

In order to avoid errors of interpretation in roentgenograms of the shoulder one must take several views.

Ossification within the epiphysis of the acromion is rarely evident before the middle of the fourteenth year.

Complete ossification of the acromion epiphysis takes place about the middle of the eighteenth year.

Complete ossification within the upper epiphysis is evident about the nineteenth year.

There is no trace of the epiphyseal line at the twentieth year.—*Thomas Madden Foley, Washington, D.C.*

THE CHALLENGE OF THE CHRONIC PATIENT TO THE MEDICAL PROFESSION. Joel E. Goldthwait. *Boston Medical and Surgical Journal*, January 12, 1922, p. 31.

When considering the subject broadly, it can hardly be denied that our profession as a whole has but little interest in chronic medicine or that the interest is distinctly less than it was a generation ago. The author states that our basis is one normal structure, *i.e.*, anatomy. Practically none of the

cases of chronic disease are of this normal structure. Not only do individuals vary in structure,—muscles, bones, viscera, and potentials of activity,—but considerable regularity of such structures carries with it its own potential of disease.

The author speaks of the low back condition which probably leads, more often than any other, to medical advice being sought for relief. This is not unreasonable when the great variations in structure are appreciated, together with the imperfect mechanics in use. The understanding of the types, shapes, and number of lumbar vertebrae aid in the diagnosis of low back pains. Some individuals are so built that the abdominal organs are relatively small, allowing a large range of comfortable motion, but to another person such range of movement would cause injury. The length of the intestines varies. Once anatomic features are recognized and the function of parts considered in the varying ways in which the body is used, it requires little imagination to at least see the possibilities of difficulty. Orthostatic albuminuria is often so called because lordosis is the essential feature in producing this symptom. It may not be indicative of serious functional disturbance, as generally believed by our profession. Also with the visceroptotic patient there is always more or less ptosis of the diaphragm, and since the flow of blood from the abdomen back to the heart is almost entirely dependent upon regular action of the diaphragm (milking the abdominal veins against the upward opening valves), it is fairly easy to believe that some of the abdominal symptoms or disturbances in the physiology are due to the disturbance in the circulation, resulting from the position in which there is inaction of the diaphragm. The latter can be easily demonstrated by fluoroscopic examination. The author speaks of cases observed in American Expeditionary Forces which were diagnosed D. A. H. (deranged action of the heart), and subsequent exercises, which favored the holding of the back erect, cleared up the heart symptom. The correction of the mechanical feature thus relieved the physiological distress and pathological manifestation.

The author discusses briefly the problem of the chronic arthritis and points out its complexity and disturbance of physiology. Bad teeth and tonsils should be removed as a hygienic measure. Most cases of chronic arthritis, however, are influenced by altered physiological conditions, existing in the abdominal viscera. The drainage of organs may be altered or the secretions too much or too rich or alterations in the balance favor the growth of bacteria. —*Voigt Mooney, Pittsburgh, Pa.*

OSTEOCHONDRITIS OF THE HIP, OR COXA PLANA. Is an Unrecognized Congenital Dislocation. F. Cabot and H. Colleu. *Press Médicale*, No. 4, January 14, 1922, p. 35.

Many theories of causation of this condition have been advanced, but Legg is the only one to have established a relationship between the lesions observed and the deformities that one encounters in reduced congenital dislocations,

but he has denied all connection between the two and even attempted to make a differential diagnosis.

However, judging by clinical and x-ray studies, the authors believe the condition to be a congenital malformation of the nature of a subluxation.

The reasons why this has not been recognized before are various.

1. We are not familiar enough with the notion that congenital lesions of the hip do not reveal themselves necessarily with the first steps or even in the following years.

2. We have not recognized that attacks of pain are important manifestations in congenital lesions of the hip.

3. One should not discard the theory of a congenital lesion being present because the classical picture of a dislocation does not leap before the eyes. The lesions present are border-line ones and can be recognized only with difficulty.

4. Especially must care be observed in order to recognize the anterior type of subluxation, because the flat x-ray plate does not give perspective.

5. It is also important to study the x-rays carefully, not only from the standpoint of lesions of the epiphysis, but also of the articular surface of the femur and acetabulum.

Clinical examination of a patient may reveal a history of the child having commenced to walk late and having had a slight limp from the beginning. This history is difficult to obtain as the parents try to hide congenital lesions. There is always slight limitation of abduction, and palpation may show the head abnormally prominent anteriorly.

The correct interpretation of x-rays of the hips is always difficult when one is dealing with slight differences. One must have a large experience to be able to recognize the normal, which is not often seen. There are many variations in the shape of the acetabulum and in these cases it will be found flatter than normal and the articular relations are abnormal.

The authors conclude that careful study of a number of cases of congenital subluxation of the hip will convince anyone that the condition known as osteochondritis, coxa plana, pseudo coxalgia, etc., is only a transitory phase in the evolution of a subluxated hip. The same congenital malformations of the hip later give rise in adults and adolescents to some of the lesions which are classed under the name of arthritis deformans.

In osteochondritis all the laboratory investigations from the point of view of syphilis, tuberculosis or infectious processes have been negative. Only the theory of a congenital lesion can explain logically the paradoxical observations which show that the observer is on the wrong track.

They conclude that it is necessary to revise a large part of our ideas regarding the pathology of the hip, and that when this revision is made, the chapter concerning congenital subluxations will be the important part.—*P. D. Wilson, Boston, Mass.*

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